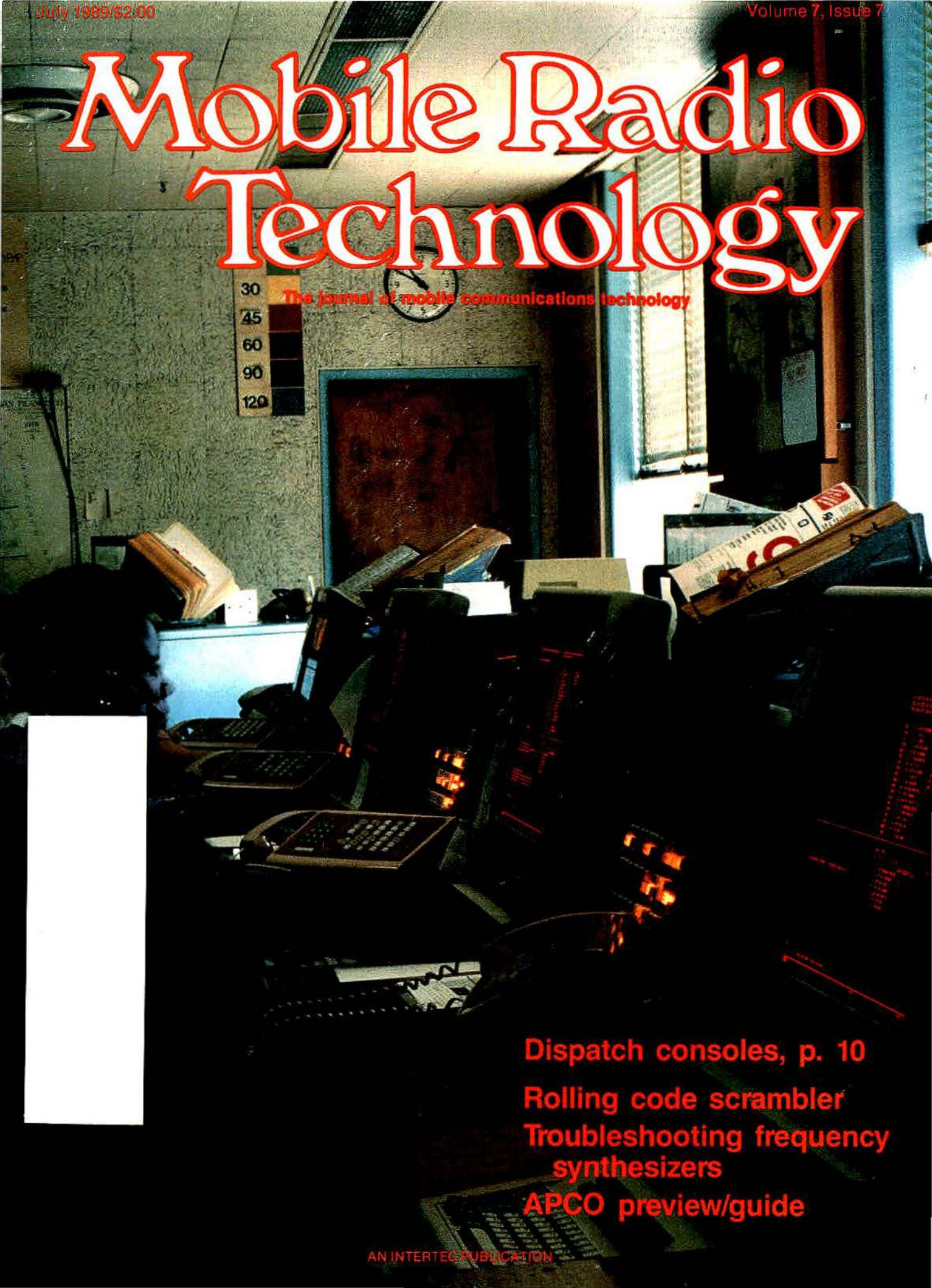
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Volume 7, Issue 7

Mobile Radio Technology

The journal of mobile communications technology



Dispatch consoles, p. 10

Rolling code scrambler

Troubleshooting frequency synthesizers

APCO preview/guide

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Paul McGee, Motorola

Today's advanced dispatch consoles integrate two-radio and telephone communications with computer-aided dispatching, digital control signaling, radiopaging encoders, monitoring equipment and auxiliary controls.

20 Frequency synthesizers: Troubleshooting techniques

Harold Kinley, CET, South Carolina Forestry Commission

Part 2—Keeping in mind the frequency synthesizer basics from last month's installment, it is time to work through a troubleshooting example.

42 A rolling code scrambler gathers diverse functions

E.J. McKernan, Midian Electronics; and Bill Scott, CommTech

A "bit" here and a "bit" there deliver functions that include system and unit identification, status and location information, selective calling, remote control and telephone interconnect—in what started as a scrambler!

60 APCO National Conference preview/ guide

Use our session guide, exhibitor list and exhibit floor map to get the most from your visit to the 55th Annual Associated Public-Safety Communications Officers National Conference.

On the cover: San Francisco's Department of Electricity maintains the police department's 17-year-old dispatching center. Obsolete computer and radio system control hardware requires custom parts fabrication.

See page 10 for Paul McGee's review of dispatch console technology.

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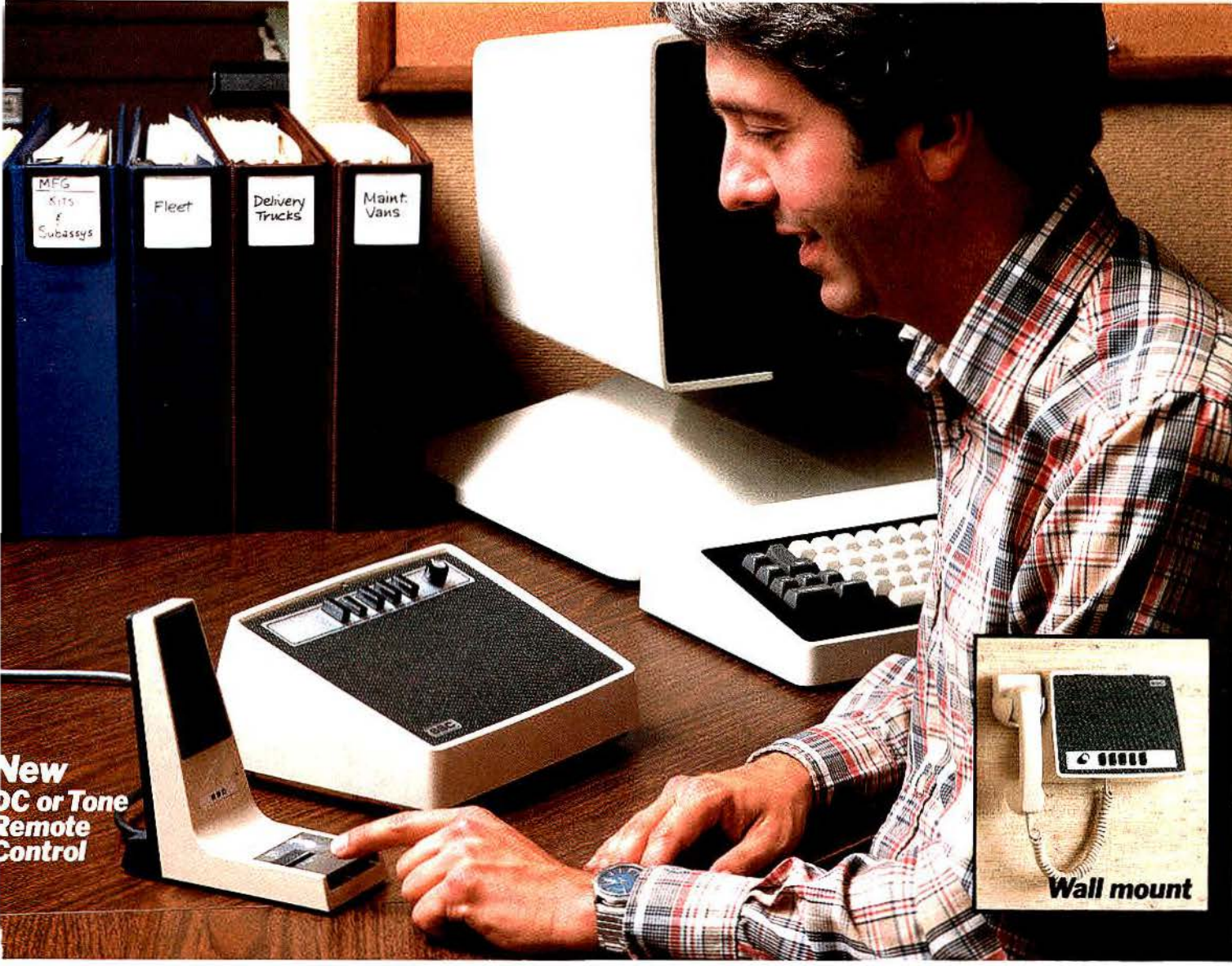
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Mobile radio with class—or brass!



Last month in this space we showed you one of the most extensively equipped radio communications vehicles, a Laughlin Township, NV, constable's vehicle with *nine* antennas and a radio for each skyhook.

We asked whether anyone could top that. What should come in the mail but a photo and story about a mobile unit with only two antennas. But get the date of installation: 1908!

The radio operator could select a 10-foot or a 25-foot antenna. Selective calling? The spark transmitter did not select anything, including frequency. Encryption? He who pounds the brass picks the code!

We could go on, but you get the idea.

OK, can anyone top *this?*

* * *

Editorial review board

Since March, a number of readers have been kind enough to review each month's issue by filling out a survey. The readers form our "Editorial Quality Review Board."

What these readers are helping us to do is to evaluate how well our features and departments serve them.

They represent you.

You can represent yourself, though. Current board members' terms expire at the end of August. Would you like to help us guide *MRT* during the next six months? You'll have a rare opportunity to influence the direction of what we hope is your favorite industry publication.

But if *MRT* is not your favorite *yet*, the better we fine-tune ourselves with your help, the more likely we are to *become* your favorite.

Write to me at *MRT*, P.O. Box 12901, Overland Park, KS 66212 or call me at 913-541-6627 if you would like to join the Editorial Quality Review Board.

—Don Bishop

MODERN ELECTRICS

Auto Equipped With Wireless

By Our Brussels Correspondent.



Photo by N. E. Auto Journal

We reproduce herewith a photograph of a novelty exhibited at the last Brussels automobile show. It is a regular wireless sending and receiving station installed in a Limousine car in use by the artillery corps of the Belgian army, and so far has proven entirely successful.

In the interior of the body the operator is seen manipulating the sending key. Under the table a 4" Rhumkorff spark coil is installed, also the storage batteries for sending and dry cells for receiving.

On the table on the left side of key are the coherer and tape register; the oscillators and adjustable condensers are in the background. The coherer is suspended in a four-ring pivoted system, which, in turn, is suspended on strong rubber bands. This arrangement makes it possible to receive messages accurately and keep the coherer always horizontally. Shocks and vibrations resulting from travelling over rough roads have little effect on the arrangement. The antennae is a collapsible mast, which is about 10 feet high; it is attached on the roof of the Limousine. If obstacles are encountered, the mast can be laid down on the roof. An extra antennae is also carried and can be fastened on top of the regular aerial mast. It is made of thin brass tubes, which telescope into each other. Extended and placed on top of the regular mast, the height of aerial can be increased up to 25 feet.

The ground connection is made by trailing a metallic netting between the rear wheels of the automobile. This has been found quite satisfactory and gives an excellent "ground," except on very dry, dusty roads or on very dry asphaltum streets.

CATCHES PORTO RICO WIRELESS MESSAGE IN NEW YORK.

A wireless message from San Juan, Porto Rico, was picked up recently by an experimental receiving apparatus installed in the tower of the Times Building, in Times Square, and was clearly read by the operator after the stations at Washington and Key West had declared they could not "take" it on account of interference. This was incidental to a series of experiments being conducted by John L. Hogan, Jr., of Cos Cob, Conn., who is perfecting an instrument to prevent interference in the sending and receiving of wireless messages. The distance from San Juan by air line to the Times Building is approximately 1,600 miles.

One of the first vehicles equipped with a two-way radio is a horseless carriage—the driver sits outside the passenger compartment. Notice the radio operator's hand on the telegraph key, almost dead-center in the photo. Reprinted from the first edition of *Modern Electrics* magazine, April 1908.

PRIVACY NEWS from transcrypt

Volume 1, No. 5

NEW TECHNOLOGY FOR TODAY'S RADIOS

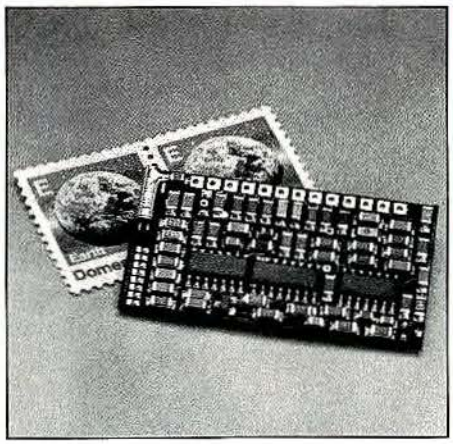
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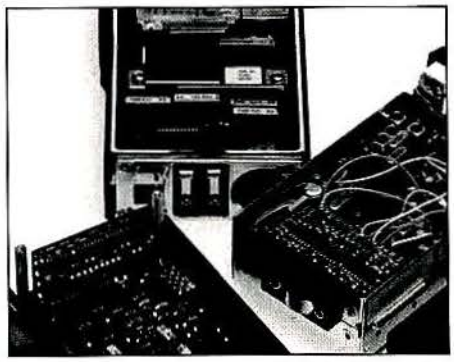
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Letters to the editor

'Too greedy'

I run a small, one-man shop part-time to supplement my regular income. Most of my work involves repairs and service. But when I have an opportunity to sell new equipment, it is unavailable to me. My distributors do not have access to all equipment lines and radio manufacturers only want to sell to shops who sell millions of dollars worth of equipment per year. People have become too greedy.

Chuck O'Connor
O'Connor Communications
San Jose, CA

Science club radio stations:

On Nov. 20, 1987, the featured speaker at the annual awards presentation of the Radio Club of America was I.M. McKenzie, managing director of Philips Radio Communication Systems of Cambridge, England.

Among other things, he said, "The area of fastest, furthest reaching change is in mobile communications...developments that may well change the whole scope of our lives."

In March 1988 in St. Louis, Telocator displayed renewed vigor as a result of reorganization and the selection of a new president.

At the meeting, Telocator announced 10 goals. Goal No. 9 is: "Promote education and training for current and future personnel."

On. Nov. 9, 1988, a retired FCC radio inspector filed a petition with the commission to modify the basis and purpose of the amateur radio service to include using the amateur service to stimulate secondary school students' interest in school curricula, especially science and mathematics.

Do you realize that those three separate events may well change the whole scope of our lives? The former radio inspector's petition points out that presidential candidate George Bush said he wanted to be the *education president.* Now he is the president.

The petitioner pointed to the "negative press" the educational system receives. He pointed to the inferiority of masses of students who are not interested in science and mathematics, in contrast to the interest they displayed in those topics during the early days of the Radio Club of America.

The former radio inspector asked the commission to create "science club radio stations" in the amateur service. He asked the agency to make science club station licenses available without examination to Scoutmasters and to middle and high school science teachers.

Suppose these developments occur:

(1) The president promotes students' pursuit of a science and mathematics education as being a patriotic gesture on the students' part, a gesture intended to help to make the U.S. electronics industry competitive worldwide.

(2) The FCC, responding to the radio

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The journal of mobile communications technology

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inspector's petition, and support I hope will be expressed for it by the American Radio Relay League and individual amateur licensees, makes science club stations available to groups interested in the sciences, in technology and in mathematics.

(3) Telocator and other industry trade associations see fit to promote science club station operations.

Think of the groups that would use these science club stations as following in the footsteps of the Radio Club of America. These science clubs will produce scientists, technologists and industrialists. That is what the Radio Club produced in the early 1900s. As a result, the United States led the world in manufacturing for years.

If these developments happen, Mr. McKenzie would turn out to be a real prophet because "the scope of our lives would change."

He could not foresee each of these developments happening in concert. But science and mathematics played a roles in the history of wireless from the times of Faraday and Hertz—until Americans all decided to become entrepreneurs and industrialists. The current state of affairs demonstrates the need for government and industry to promote something besides business.

Science clubs will promote science, technology and business. We'll be sitting tall in the saddle again!

G.M. Howard
Communications Attorney
Dallas, TX

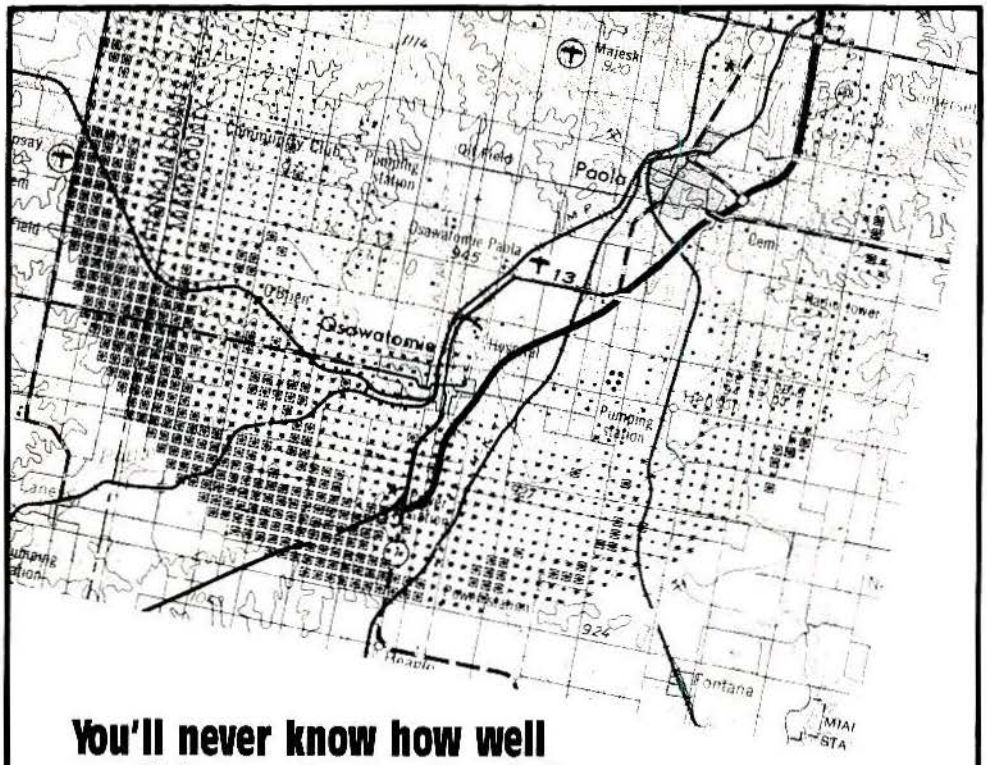
Fast Fact Card comment:

The October 1988 issue is very good. You try to cover a broad variety of topics without bias. Keep up the good work.

I especially enjoyed, "Wind Augments Solar Power At Mountaintop Radio Site."

The two toughest problems are the "I want it yesterday" attitude and rapidly changing technology.

John W. Hood
Communications Technician
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Correction

Here is the correct diagram for Figure 5 on page 58 of the April issue:

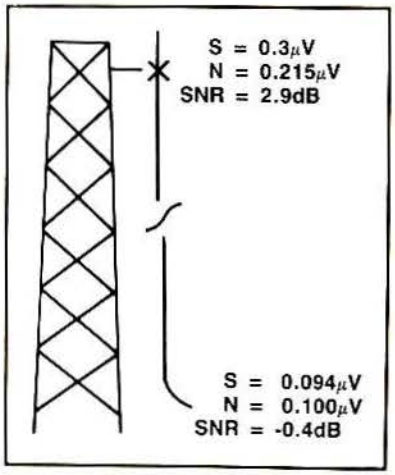
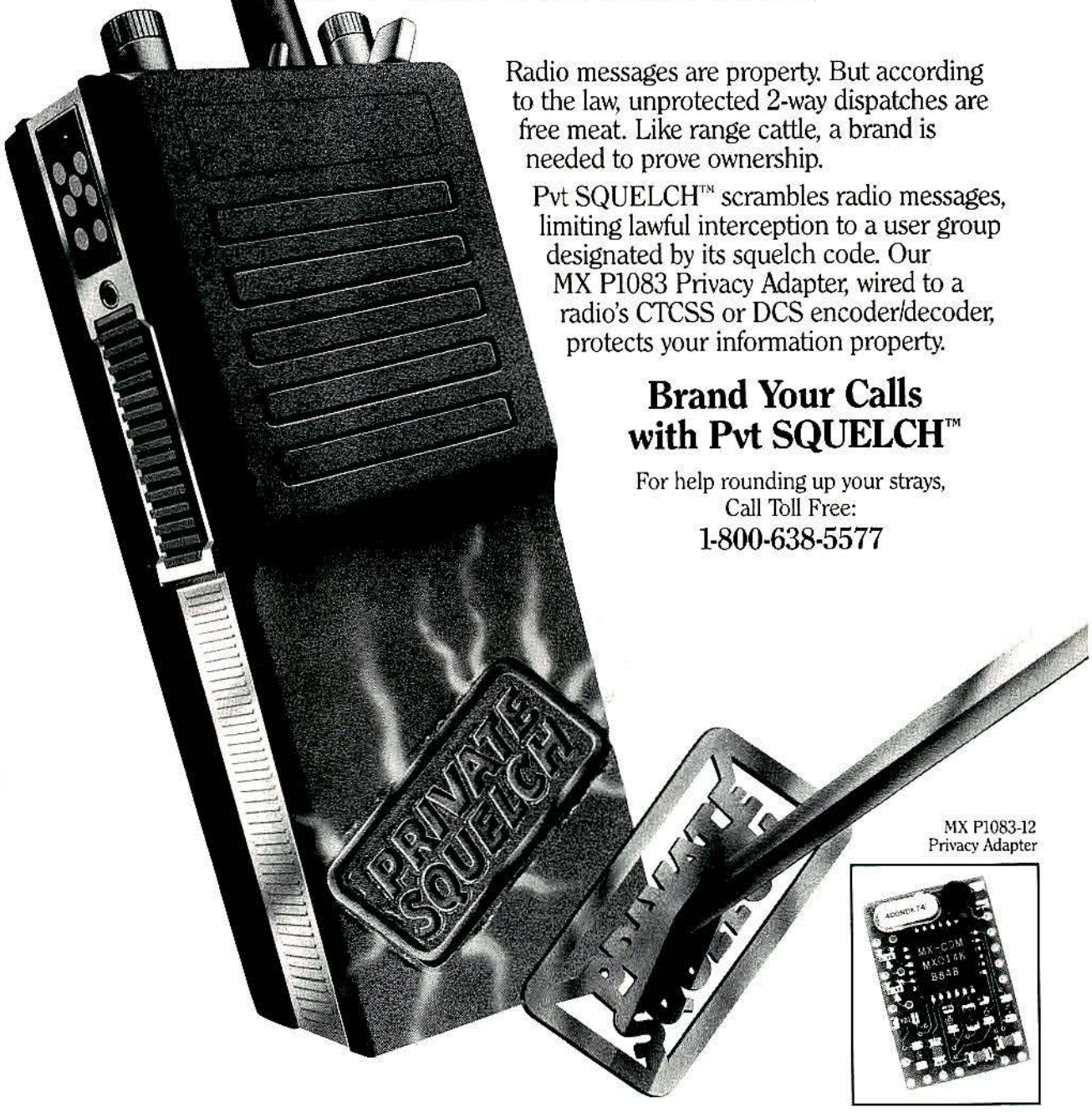


Figure 5. Signal and noise levels at a high-noise site, without an amplifier.

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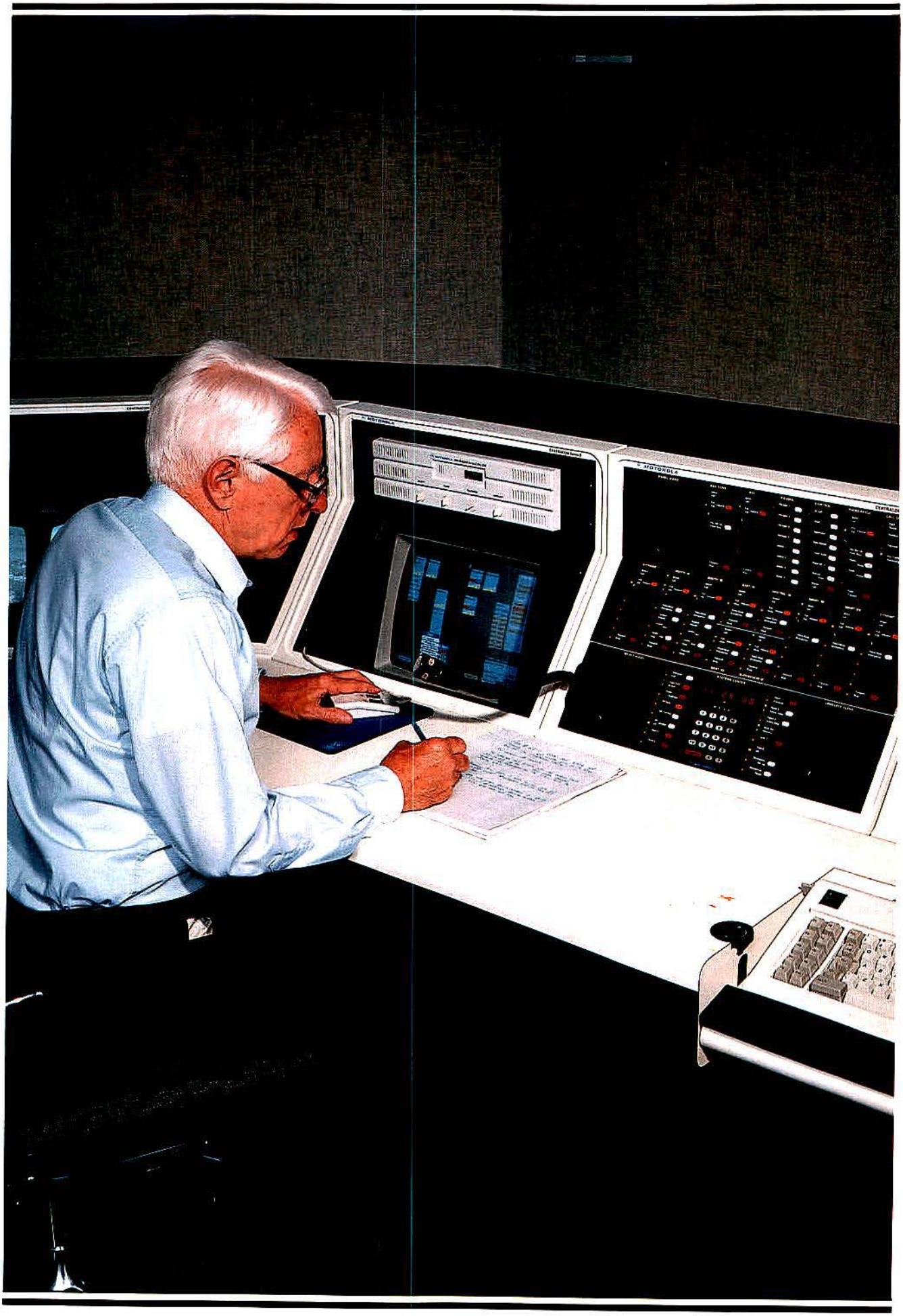
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Dispatch consoles are communications *integrators*

Today's advanced dispatch consoles integrate two-way radio and telephone communications with computer-aided dispatching, digital control signaling, radiopaging encoders, monitoring equipment and auxiliary controls.

By Paul McGee

When a member of the public telephones for emergency help from a public safety agency, a telecommunications dispatcher normally receives the request. A dispatcher relays requests received by telephone via radio, intercom or telephone to one or more police officers, firefighters or emergency medical technicians.

Dispatch consoles control telephone lines, radio channels and other communications links to speed messages between people in the community and those who render aid or protection on behalf of public safety agencies. (See Figure 1 at the right.)

Dispatch console technology is advancing at a pace that matches the rapid development of radio communications systems that use trunked channels, digital control signaling terminals or computer-aided dispatch, or a combination of them.

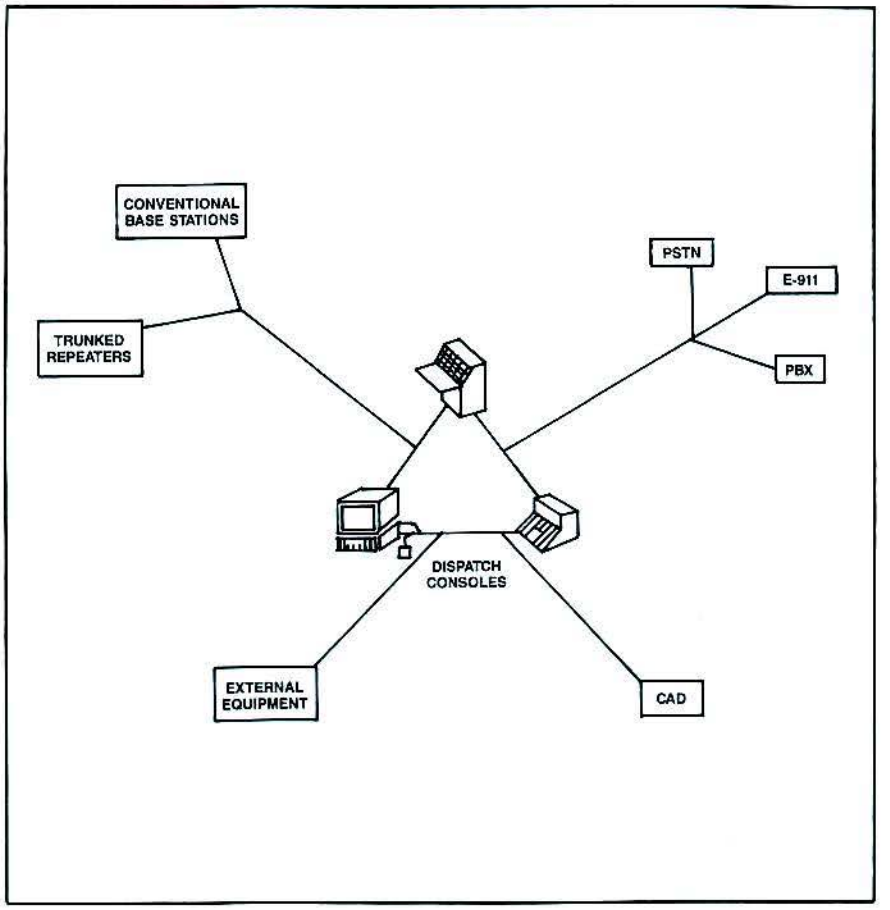


Figure 1. Dispatch consoles control telephone lines, radio channels and other communications links to speed messages between people in the community and those who render aid or protection on behalf of public safety agencies.

Early consoles

Originally, a console simply collected controls for radio channels into a small, integrated system. Push-buttons that first made positive switching contact later controlled relays, then solid-state switches. On some current console models, push-button closures are read by microprocessors that in turn control complex switching routines.

At left: Modern dispatch console flexibility includes CRT and 'buttons-and-LEDs' positions for the same system.

McGee is the product planning manager for control center products, Motorola Communications Sector, Schaumburg, IL.

Switching is involved when the dispatcher selects one or more radio channels to reach an officer or other specialist in the best position to render aid. A proper response may require placing telephone calls, sending radiopaging messages or composing written messages to be transmitted by a data terminal.

One variety of console is named for its buttons and light-emitting diodes (LEDs) that serve as indicators.

A typical "buttons and LEDs" console includes two or three buttons and indicators for each radio channel that

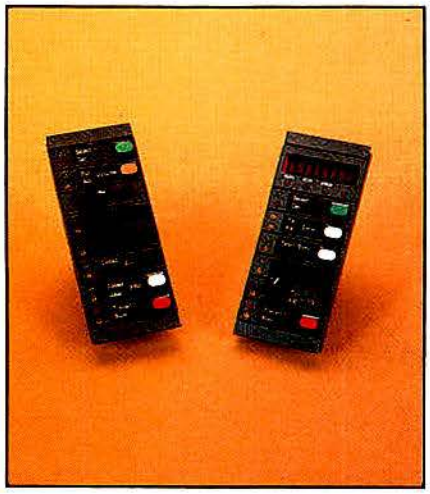


Photo 1. A channel control module (left), and a display channel control module with an eight-character alphanumeric display for call ID and channel assignment.

control switching and indicate status. It has a set of system controls for all channels. System controls include intercom, unselect channel mute, multiselect and patch.

Another typical "buttons and LEDs" console uses channel control modules. Each module uses eight buttons with indicators and controls an individual radio channel. Standard controls provide the capability to select a channel (monitor it through a select speaker and transmit via push-to-talk); adjust its incoming volume; include it in a patch with another channel or phone line; and perform a single-button-press, priority instant transmit.

Optional controls include frequency selection, audio encryption control and channel priority. In addition to showing the status of the controls, LED indicators show whether a call is incoming and whether one dispatcher or another is transmitting on the channel.

CRT console

The generation of dispatch consoles that has followed the "buttons and LEDs" type uses a cathode-ray tube (CRT).

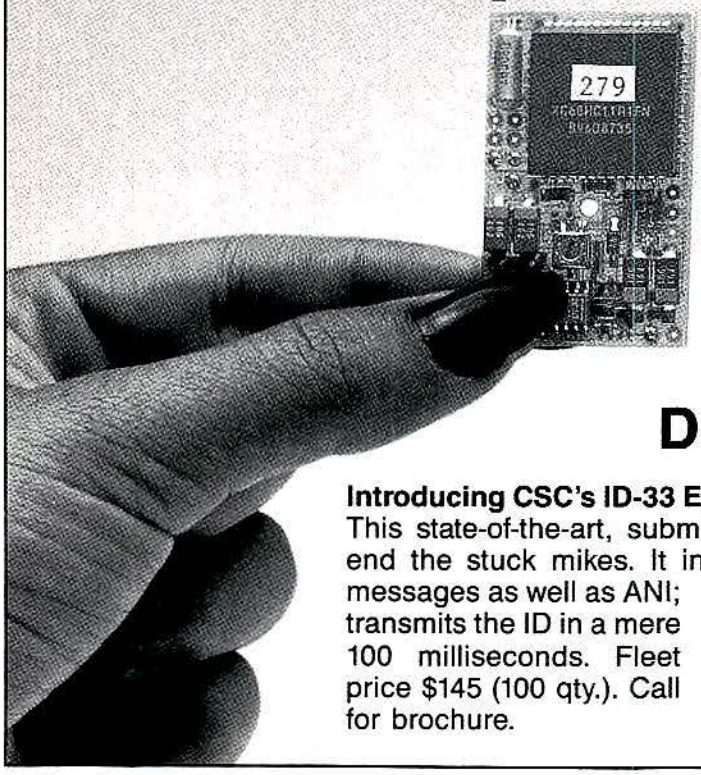
All the consoles indicators and, in some cases, most of its controls appear on a CRT. Using a CRT combines access to a higher number of radio channels without increasing the desk space required to control them.

With a "buttons and LEDs" console, positions of the buttons and indicators are not easily changed. With a CRT, channels under control by a given dispatching position, functions that may be carried out and the appearance of the screen itself easily are changed to suit different situations and personal tastes.

CRT consoles may be operated by keyboard, a mouse or a trackball, or a combination.

A mouse is a hand-sized device connected by wire with the computer. A ball mounted underneath the mouse rotates by friction as the mouse is slid one way or another across the desktop. The cursor, an indicator on the CRT, moves in concert with the mouse to a position on the screen corresponding to a function to be carried out. Buttons on the mouse operate as does the "enter" key

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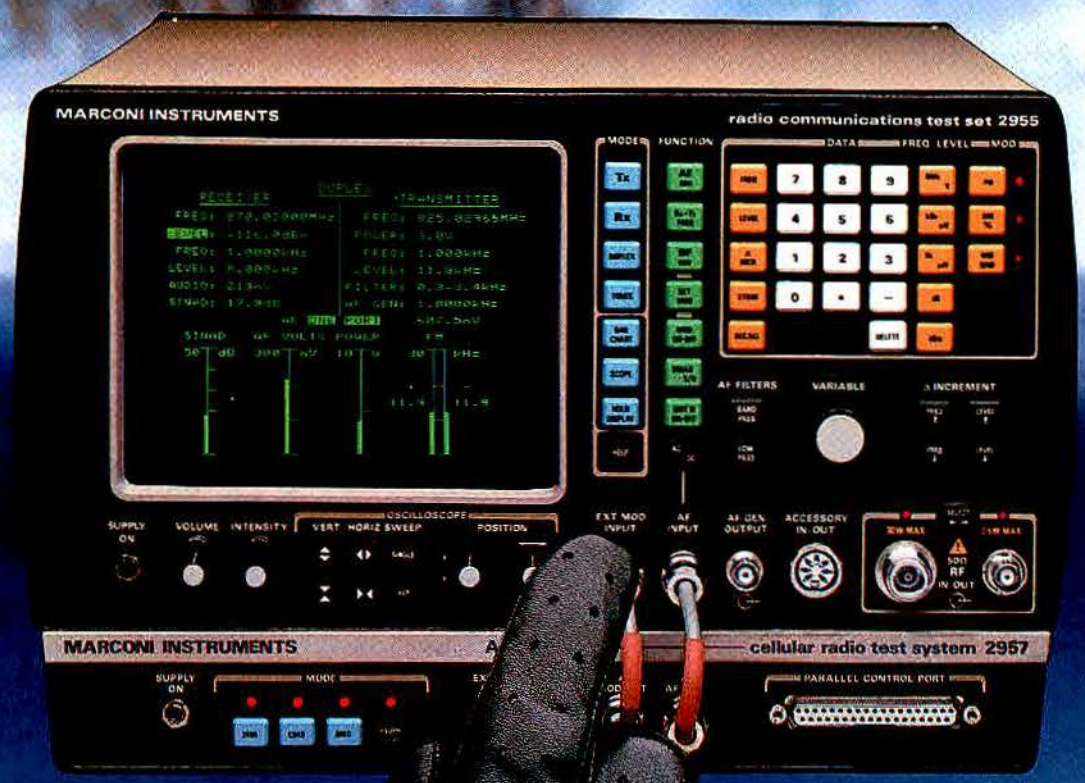
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Table 1—Some of the telephone functions available with dispatch consoles.

INITIATING PHONE CALLS:

- ☐ ***Direct dialing*—The common way of telephoning by taking the phone off the hook and dialing the number.**
- ☐ ***Ring-down lines*—Taking the phone off the hook causes a phone at the other end of a dedicated line to ring.**
- ☐ ***Speed dialing*—A phone number recorded in electronic memory is dialed with the press of a single button.**
- ☐ ***Alias dialing*—Phone numbers recorded in electronic memory are dialed by using a numeric or alphanumeric alias, such as '23,' 'PD13' or 'Jones.' Alias dialing may require less panel space than having many speed dialing buttons.**

RECEIVING PHONE CALLS:

- ☐ ***Standard operation*—Each phone line is represented to the dispatcher. When a call is received, visual and audible indications are given. Multiple calls give multiple indications. The dispatcher can answer, place on hold and retrieve calls in any order.**
- ☐ ***Call queuing*—Calls are 'lined up,' with the oldest calls at the top of the queue. The dispatcher presses a button to answer the oldest call.**
- ☐ ***Hold queuing*—The dispatcher can place several calls on hold, then pick up the oldest one by pressing a single button.**

on a keyboard to activate the function pointed out on the screen by the cursor.

A trackball is like a mouse turned upside down. The operator rotates the ball in one direction or another to send the cursor to different positions on the CRT.

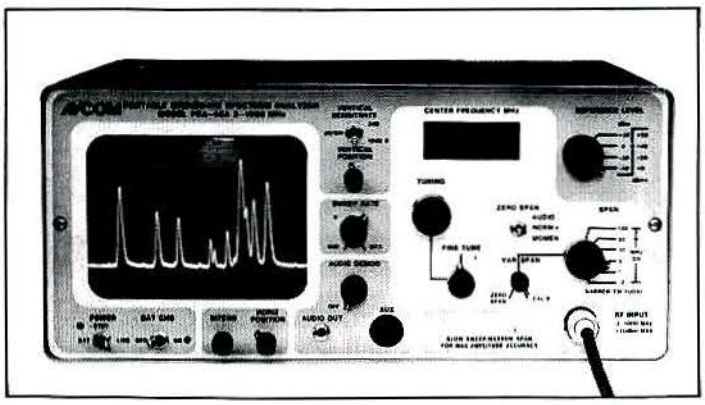
Hybrid

One fresh development in dispatch console technology—display channel control modules (DCCMs)—combines the "buttons and LEDs" approach with the flexibility of the CRT console.

DCCMs resemble ordinary channel control modules, except they have an alphanumeric display at the top. (See Photo 1 on page 12.) DCCMs offer advantages compared to the non-display version: assignability and identification (ID) display.

Assignability allows the dispatcher to reassign quickly which subfleet the module controls. Subfleets may be distinct groups of units within a given agency, such as patrol districts, detectives, supervisors or others.

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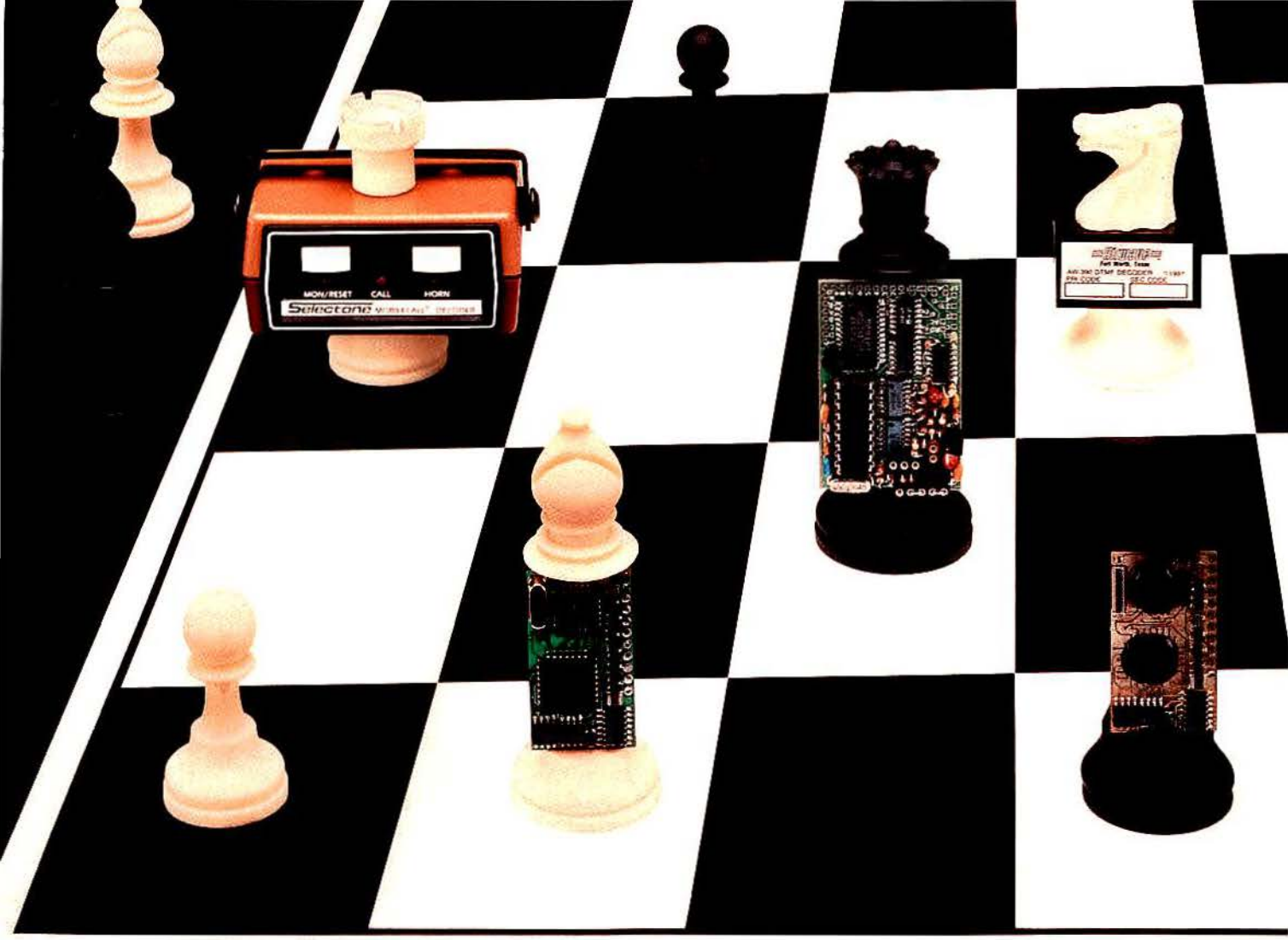
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For example, a console may have several ordinary CCMs permanently assigned to critical subfleets. One or two DCCMs can be made available for reassignment as necessary to any other subfleet.

A console may be equipped exclusively with DCCMs so it can be completely reconfigured as required by any situation. DCCMs can be reassigned by the dispatcher directly, by remote control from a supervisor's position or under automatic control by a computer-aided dispatch system's host computer.

ID display

ID display, when used with selective signaling, reveals either a numeric ID or an alphanumeric alias for individual radios. The dispatcher uses the display to identify who is calling, an advantage that is especially helpful in the case of emergency calls.

With some console systems it is possible to combine two or all three of the advantages offered by display channel control modules, assignability and ID display.

Dispatch console flexibility does not end with the way radio system controls are displayed. It extends to the way dispatchers can use radios to communicate.



Full console capabilities are available in compact, desktop versions.

Traditional radio communication has been conducted with subfleets. Although the dispatcher may be speaking with one mobile unit, what the dispatcher says is heard by all units in the subfleet. In some systems, all units in the subfleet also hear the responding unit.

Selective signaling allows the dispatcher to conduct a private conversation with one unit. Selective signaling uses digital codes or a sequence of audio tones to activate the speaker on a particular mobile unit while leaving the remaining units' speakers silent.

The ID display provision is based on selective signaling.

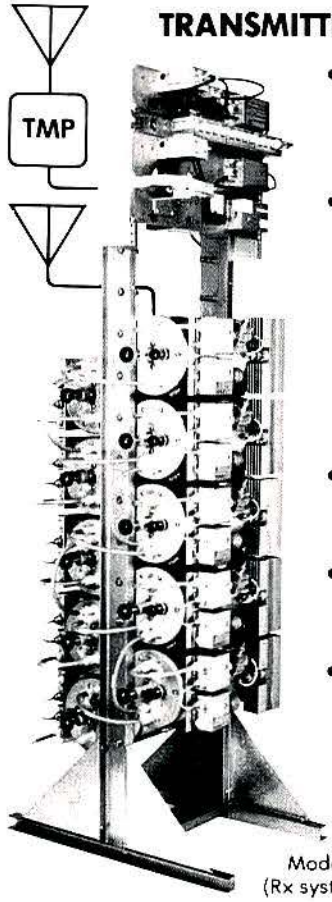
Additional capabilities made possible by selective signaling include:

- stacking aliases or numeric IDs of the most recent calls received, allowing the dispatcher to step away from the operating position and to review calls received upon returning.
- displaying the current status of radio users. Status messages may be sent

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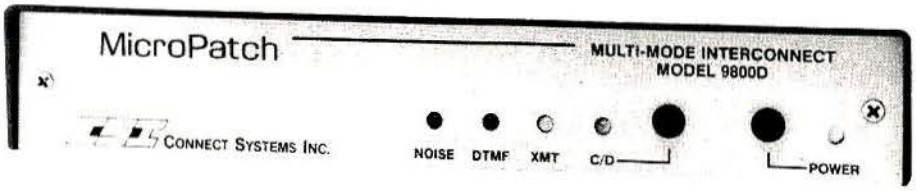
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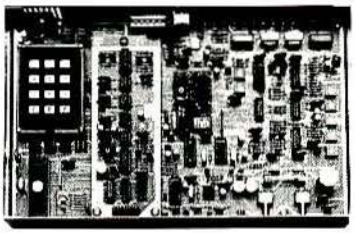


MicroPatch has **trumped** *all* competition with a **winning hand** of features like multi-mode programmability, 90 phone number autodialer, last number redial and more.

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as a data message, without voice transmission.

• logging and printing call and status histories for management reports.

• receiving emergency calls from a mobile operator.

Integrated capabilities

It has not been uncommon to add functions to an existing dispatch console by mounting other devices, such as a telephone call director or a paging encoder, alongside the radio controls. But presently, more communications managers request these devices be integrated into the dispatch console.

• *Telephone*—For example, some communications managers want telephone functions integrated with the console to simplify dispatching by making radio and telephone control as similar as possible.

Telephone integration allows the dispatcher to interconnect radio and telephone communications easily. Telephone integration makes it possible to use the same headset or handset for radio and telephone conversations.

Table 1 on page 14 lists some of the ways telephone calls are made, ways that can be facilitated by integrating the telephone with the dispatch console.

For communications managers who want to keep telephone controls separate from radio controls, limited integration can be achieved by connecting a patch bus into the console to facilitate radio-to-telephone interconnection.

• *Paging encoder*—Another instrument that can be integrated with the console is a paging encoder.

With an integrated encoder, the dispatcher can mix the encoder controls with radio system control buttons or access the encoder controls through the CRT to save space.

Integration of the encoder controls allows the format, code, channel and frequency for programmed paging messages to be stored to send one or a group of paging messages quickly.

• *Monitoring and control*—Dispatch consoles offer the capability to control or monitor external equipment.

For example, making the controls to an instant recall recorder part of the console saves space; the recorder may be placed away from the console.

The dispatch console's controls and indicators can be used to operate or monitor doors, lights and alarms.

Custom design

During the past few years, dispatch console design has changed greatly. Once a collection of buttons used to control and transmit over a radio system, the dispatch console serves in the role of integrating all communications.

Dispatch consoles exhibit versatility and flexibility. They come in all shapes and sizes, offering many ways to dispatch. They provide control functions other than those connected with basic radio communications. Today's dispatch consoles are more capable than ever of meeting centralized communications needs.

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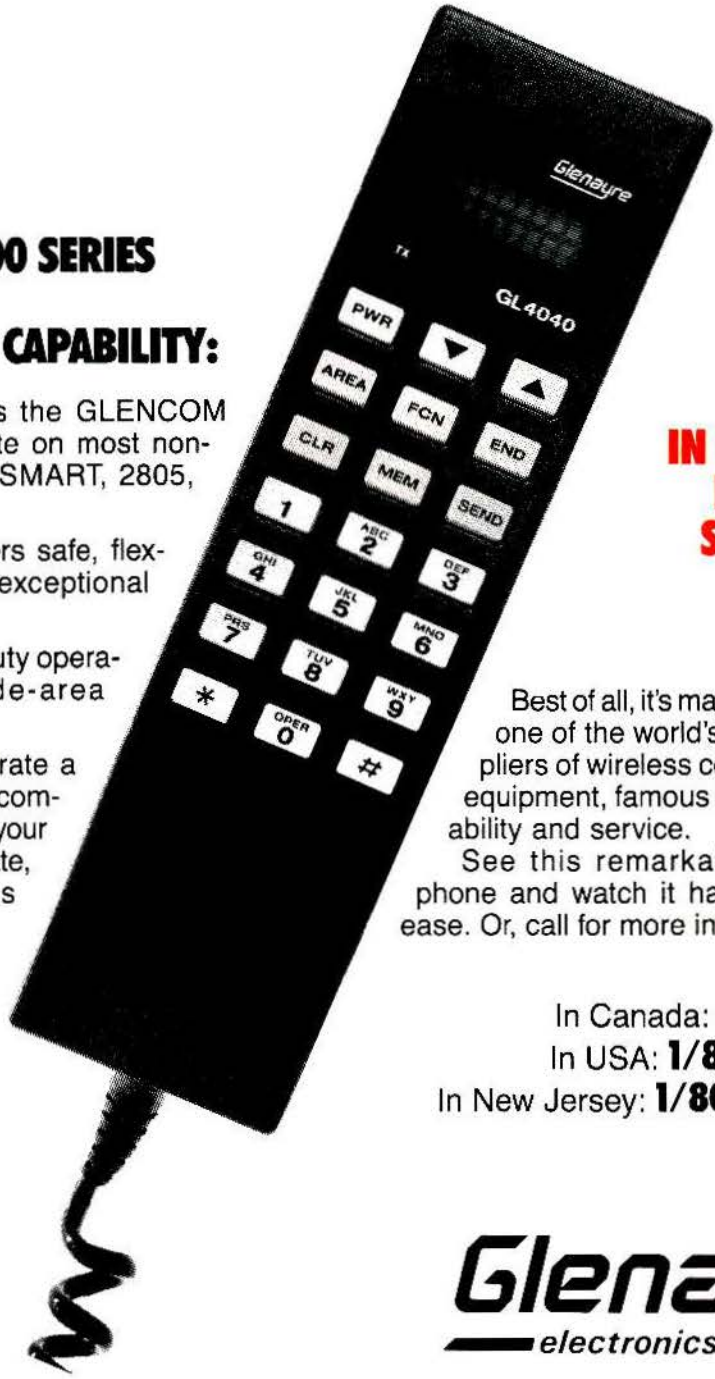
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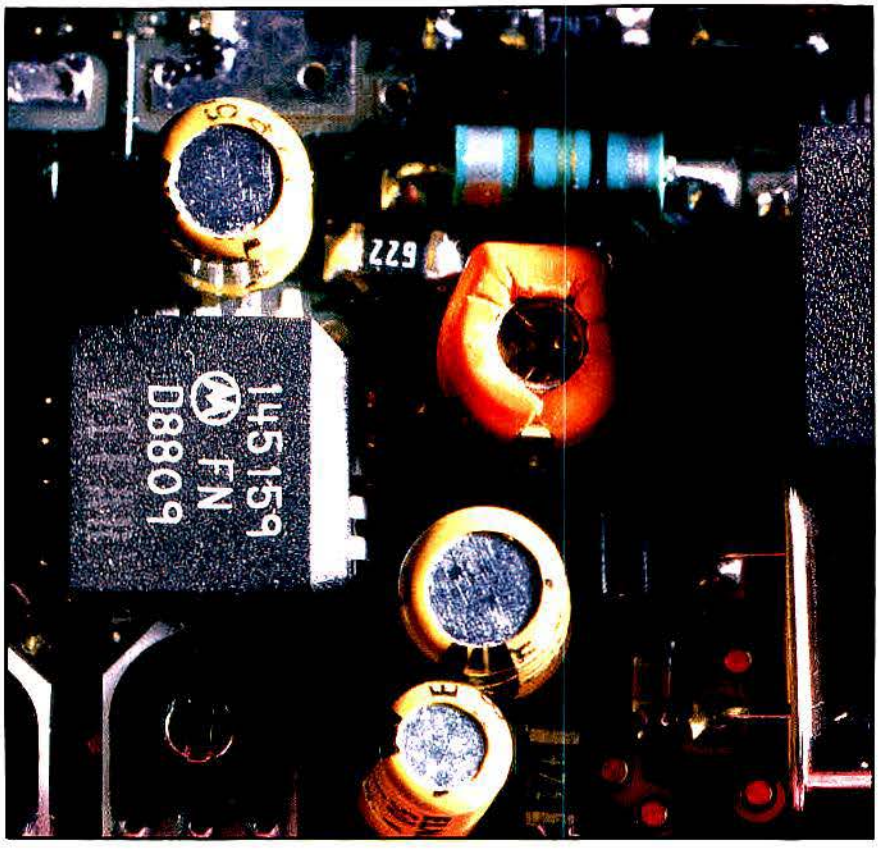
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Frequency synthesizers: Troubleshooting techniques

Part 2—Keeping in mind the frequency synthesizer basics from last month's installment, it is time to work through a troubleshooting example. Use these helpful tips to fix equipment serviced in your shop.



By Harold Kinley, CET

In last month's issue, "Frequency Synthesizers: How They Work" explained frequency synthesizer technology using general examples. This month, you will gain practical knowledge by studying an actual system.

The unit to be used as an example is the Motorola MCX100. Other models may use slightly different component arrangements. But once you gain a good understanding of how dual modulus phase-locked loop (PLL) frequency synthesizers work, you should have no trouble applying this knowledge to other systems with minor design variations.

Kinley is a certified electronics technician with the South Carolina Forestry Commission, Spartanburg, SC. His book is *Standard Radio Communications Manual: With Instrumentation and Testing Techniques*, Prentice-Hall, 1985.

Dual modulus programmable divider

The radio's dual modulus programmable divider network differs some from the one described last month. Figure 1 on page 22 shows how the dividers are interconnected.

In this setup, the prescaler moduli are ÷64 and ÷63. The dual modulus prescaler output feeds the inputs of the A and B counters. Notice that the A counter's output switches the prescaler mode and enables the B counter when the A counter reaches full count. Thus, the B counter cannot start counting until the A counter has completed its count.

The B counter's output serves as the programmable divider network's main output. Also, the B counter output presets both the A and B counters to the programmed, preset values at the end of a counting cycle.

The overall divide ratio of the programmable divider network is:

$$N = 64A + 63B \qquad (6)$$

where

N is the overall divide ratio of the programmable divider network

A is the preset value of the A counter

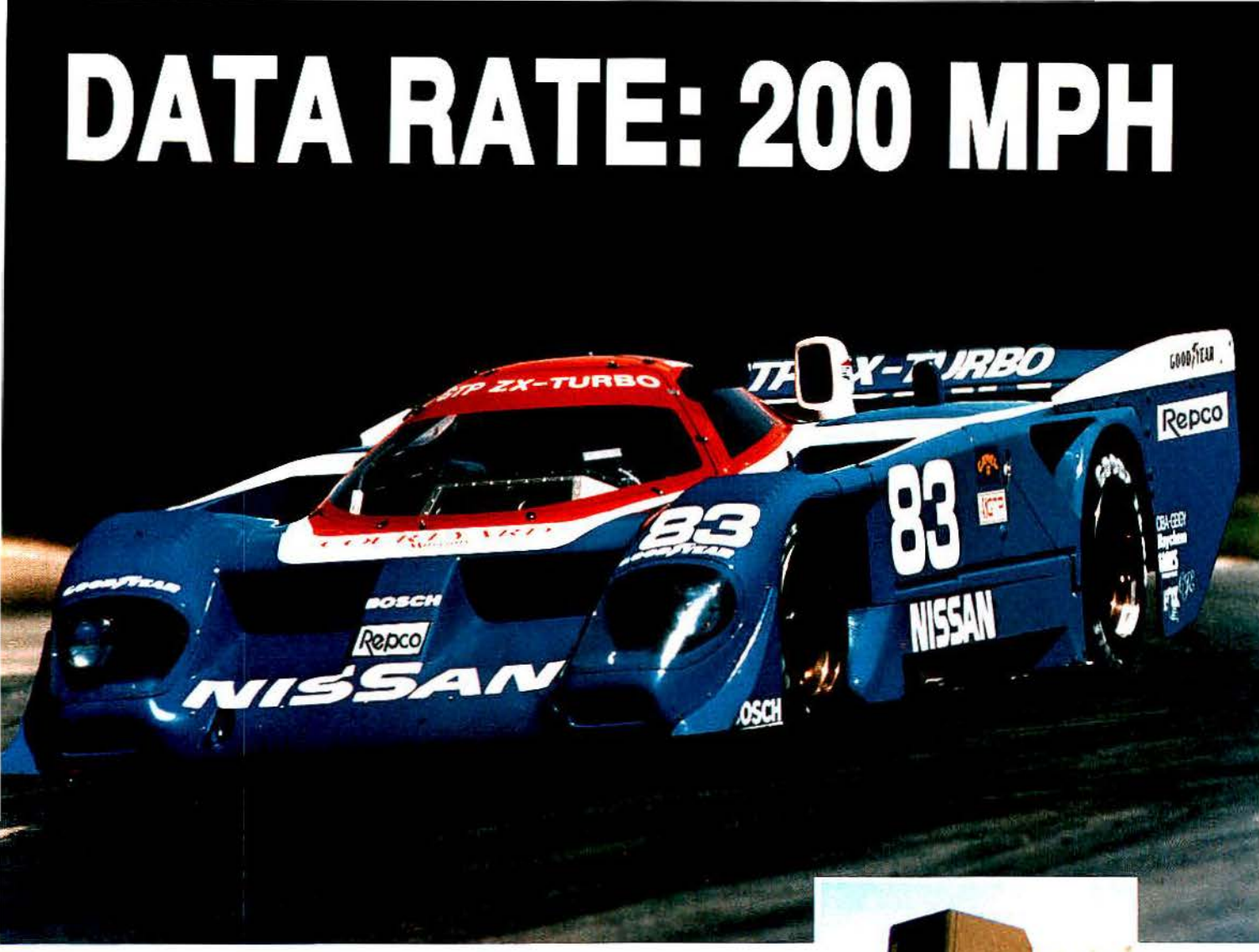
B is the preset value of the B counter

Remember, the overall divide ratio of the divider network is determined by equation (2).

The preset value for the A counter is determined by the formula:

$$A = \text{REMAINDER}(N/63) \qquad (7)$$

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With data collection at over 200 mph, Repco is redefining *high-speed data*. Using an *off-the-shelf* RDS 1201 RF data modem, this Nissan GTP car is downloading data from the race car to a computer located in the pit area. While the car is on the track, the pit crew is constantly monitoring a wide range of operating variables including oil pressure, RPM, turbo boost, intercooler efficiency, cylinder head temperature, etc., *all in real time under the most severe conditions—extreme heat, vibration, and noise.*





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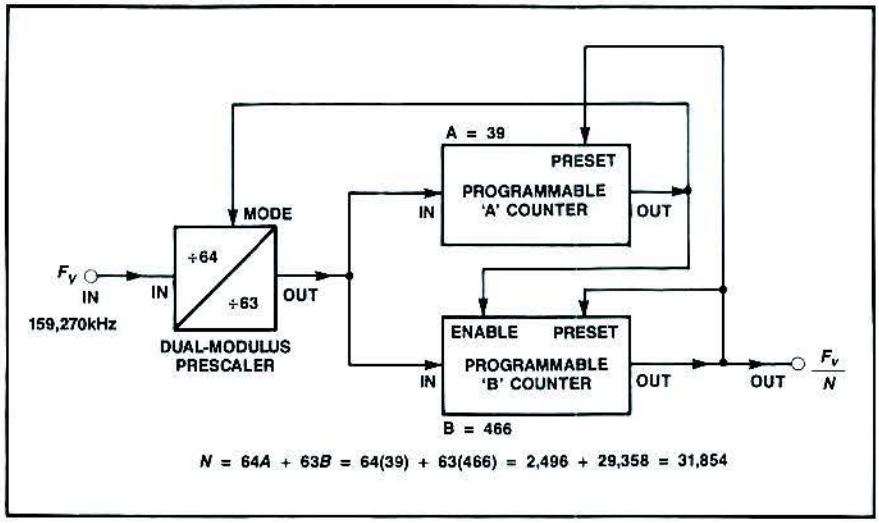


Figure 1. This dual-modulus synthesizer differs from the one shown in Part 1's Figure 10. It is used in the Motorola MCX100 radio and is discussed fully in the text.

The preset value for the B counter is determined by the formula:

$$B = \text{QUOTIENT}(N/63) - A \quad (8)$$

Example: Determine the required preset values for the A and B counters to produce a VCO frequency of 159,270kHz. (The reference frequency is 5kHz.)

Solution: From Equation 2:

$$N = 159{,}270/5 = 31{,}854$$

Using Equation 7 to solve for A:

$$\begin{array}{r} 505 \\ 63\overline{)31854} \\ \underline{315} \\ 354 \\ \underline{315} \\ 39 = A \end{array}$$

Using Equation 8 to solve for B:

$$B = 505 - 39 = 466$$

After 2,496 (39 × 64) input pulses, the A counter reaches full count and produces an output. The A counter output changes the prescaler from ÷64 to ÷63. The A counter output also enables the B counter. (At this point, the A counter becomes inactive because it has reached full count.)

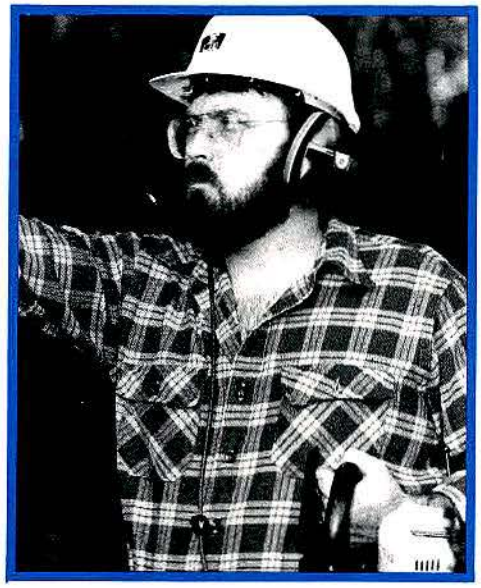
After 29,358 (466 × 63) *more* input pulses, the B counter produces an output. The output presets both the A and

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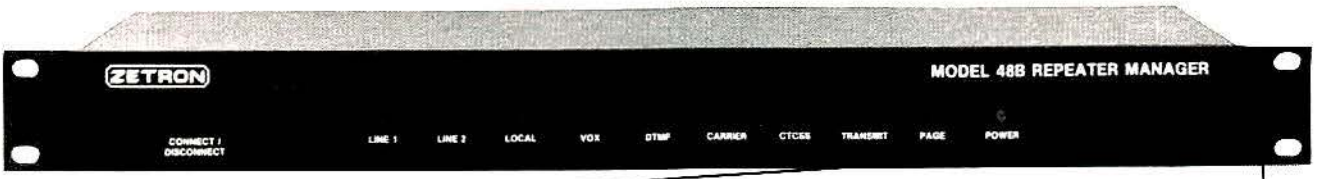
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Answer:
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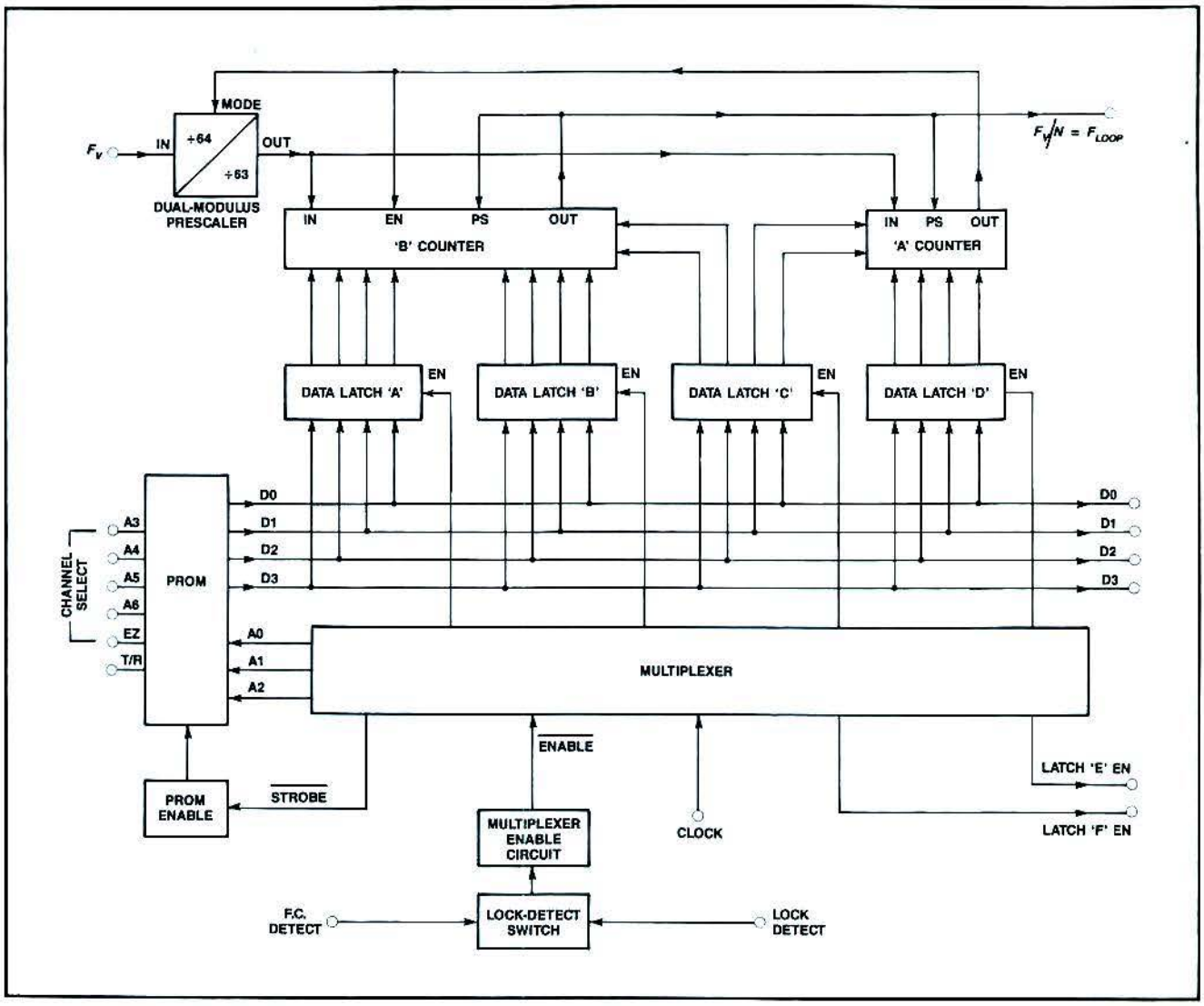


Figure 2A. This block diagram represents part of the digital circuitry used in the MCX100 synthesizer. The multiplexer is the controlling element. Once the multiplexer is enabled (by grounding the enable input), it in turn enables the PROM, addresses the PROM for data and places the data into the proper data latch. The data latches shown control the programmable dividers.

B counters and the counting cycle repeats.

The overall divide ratio N of the divider network is:

$(39 \times 64) + (466 \times 63)$

$= 2{,}496 + 29{,}358 = 31{,}854$

For the output frequency F_{LOOP} to equal the reference frequency F_R, the VCO frequency F_V must be:

$N \times 5\text{kHz}$

$= 31{,}854 \times 5\text{kHz}$

$= 159{,}270\text{kHz}$ or 159.270MHz

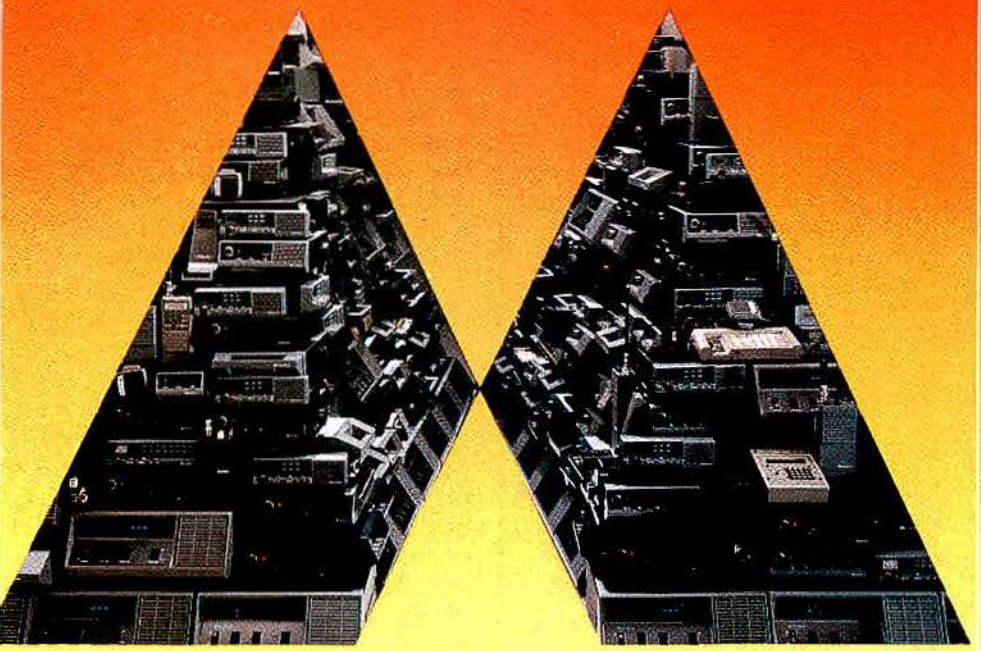
To understand how the MCX100 frequency dividers are preset or programmed, refer to Figure 2A above. Frequency data are stored in the programmable, read-only memory (PROM) when the PROM is programmed.

The memory capacity of the PROM is 2K. Data are accessed four bits at a time across data lines D0 to D3. As there are nine address lines (A0 to A6, E2 and T/R), 2^9 or 512 4-bit *words* (nibbles) can be stored in the PROM for instant recall.

Six 4-bit words are required for each frequency. As this is a 32-channel radio and the transmit and receive frequencies can be programmed independently, the PROM must have a capacity of at least $64 \times 6 = 384$ 4-bit words, so 512 is adequate.

As shown in Figure 2A, data latches (A, B, C and D) latch data bits applied to programming inputs to the A and B programmable counters. Two additional data latches (E and F) latch data used for other purposes. These two latches are shown in Figure 2B—more about them later.

Data are transferred from the PROM to the data latches when the channel selector is switched, the transmitter is keyed (or unkeyed) or the loop is out of lock. Transfer of data from the PROM to the data latches is handled by the *multiplexer—once it is enabled.*



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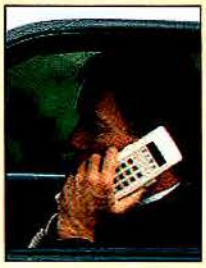


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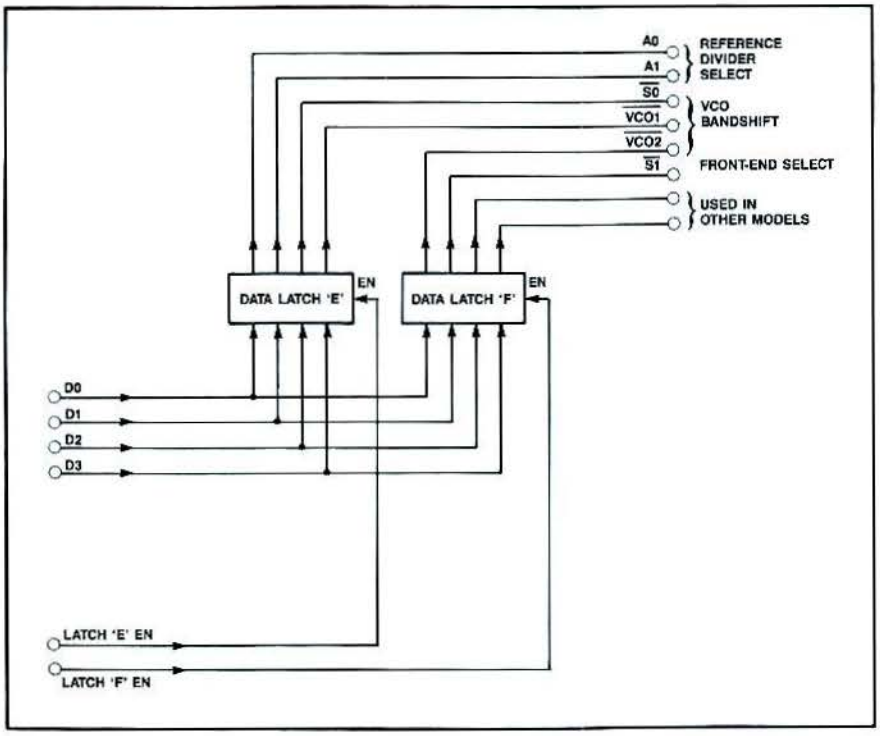


Figure 2B. These two additional data latches also are controlled by the multiplexer. The functions of the data bits in these latches are listed.

A frequency change sequence goes like this:

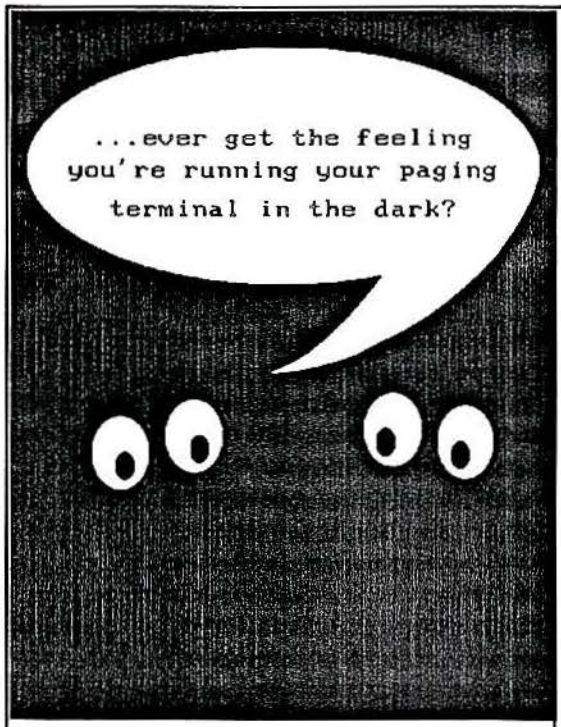
The frequency-change detector activates the lock-detect switch, which in turn activates the multiplexer enable circuit. Once the multiplexer is enabled, it does the following:

(1) It produces a 10μs *strobe* pulse, which in turn enables the PROM.

(2) Within the 10μs period, the multiplexer produces six addresses on address lines A0 to A2, producing six data words on data lines D0 to D3.

(3) It enables the latches (one at a time) to latch the designated word on the data bus. There is a unique address on lines A0 to A2 for each latch, i.e., each time latch A is enabled by the multiplexer, the same address appears on A0 to A2, placing the proper word on the data bus in its designated latch.

Figure 3 on page 28 shows how the data are accessed during one 10μs period. Data on the data bus are present only for a short period, but data on the latch output remain there until replac-



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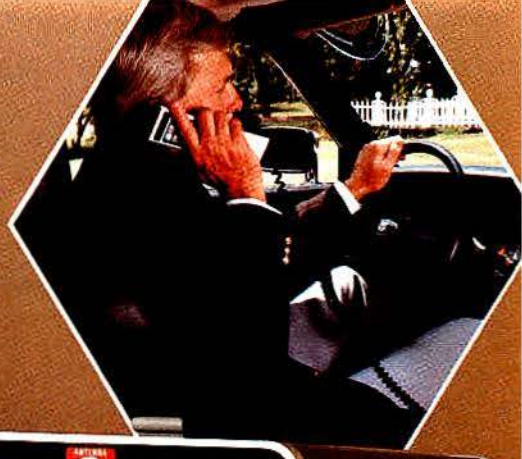
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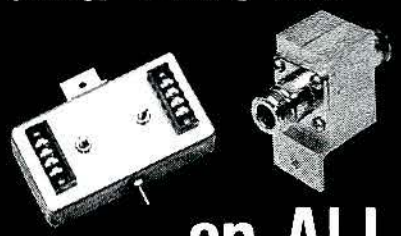
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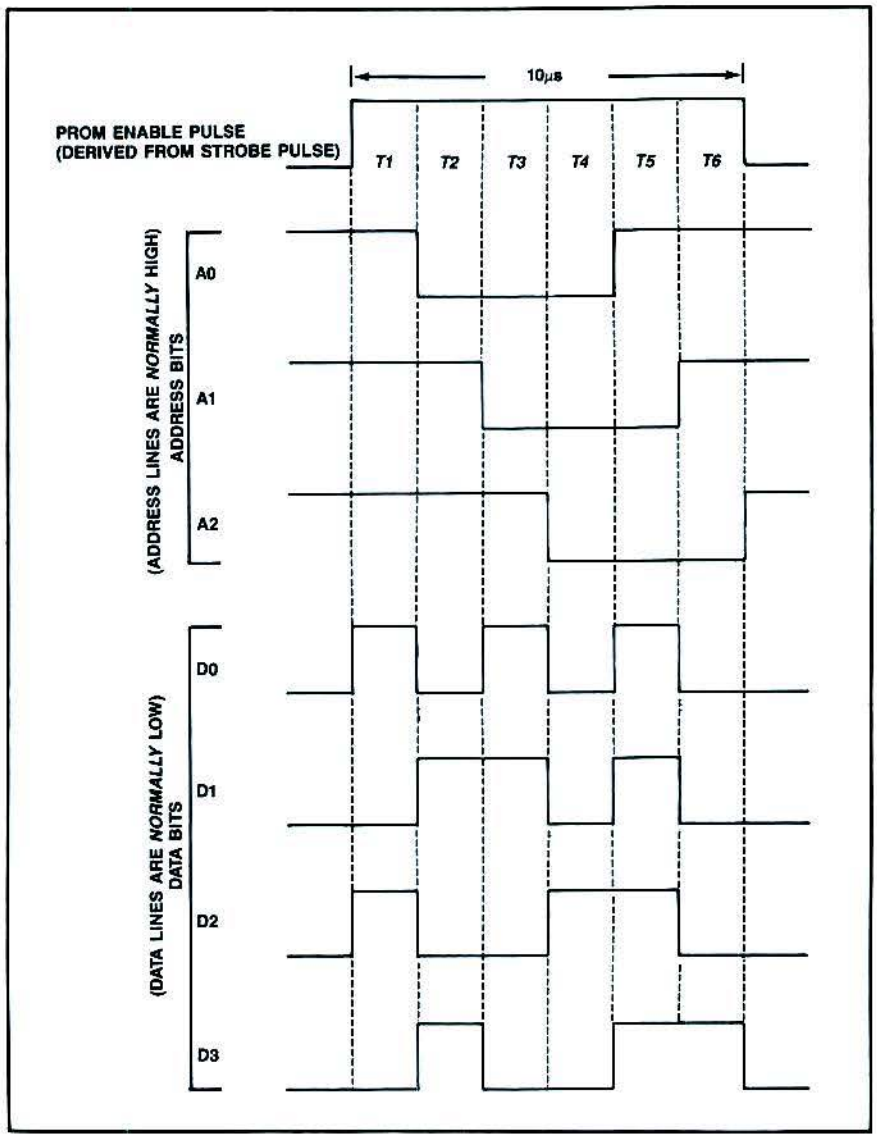


Figure 3. This timing diagram shows the relationship of the strobe pulse, the address pulses and the data pulses. The multiplexer controls them all.

ed by new data during a frequency-change sequence or out-of-lock condition. Once data are loaded into the latches and the loop achieves lockup, the multiplexer and PROM are disabled and data flow across the data bus ceases.

The clock input signal is derived from the reference frequency F_R. The repetition rate of the strobe pulse depends on the reference frequency. For example, when the reference frequency is 5kHz, the repetition rate of the strobe pulse is $1/5{,}000 = 2 \times 10^{-4}$ or 200μs.

Figure 2B shows two additional latches (E and F). The functions of the various data are shown. A0 and A1 select the reference divider divide ratio. Three different divide ratios are available; the logic levels on A0 and A1 determine which is selected.

Table 1 on page 30 shows the divide ratios and the associated reference frequency. In the VHF highband, 5kHz normally is used as the reference frequency. If the required VCO frequency is not divisible by 5, then 6.25kHz is used as the reference frequency.

In the UHF band, 4.1666667kHz is used as the reference frequency. As the VCO output frequency is multiplied by 3 to obtain the UHF frequency, the spacing is:

$$3 \times 4.1666667 = 12.5\text{kHz}$$

Figure 4 on page 34 is a simplified



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Table 1—Divide ratios for the reference divider for each reference frequency.

REFERENCE OSCILLATOR	REFERENCE DIVIDER	REFERENCE FREQUENCY
14,400kHz	÷2,880	= 5kHz
14,400kHz	÷3,456	= 4.1666667kHz
14,400kHz	÷2,304	= 6.25kHz

interconnect diagram of the synthesizer (excluding the VCO). The channel-select logic is applied to the PROM address inputs at pins 4, 3, 2, 1, 14 and 15. Address codes for each channel appear in Table 2 on page 32.

The 14.4MHz reference oscillator frequency is divided down to the desired reference frequency and applied to the reference input of the phase-frequency detector. The overall divide ratio N of the programmable divider network is determined by:

$$N = \frac{\text{(VCO frequency)}}{\text{(reference frequency)}}$$

or

$$N = F_V/F_R$$

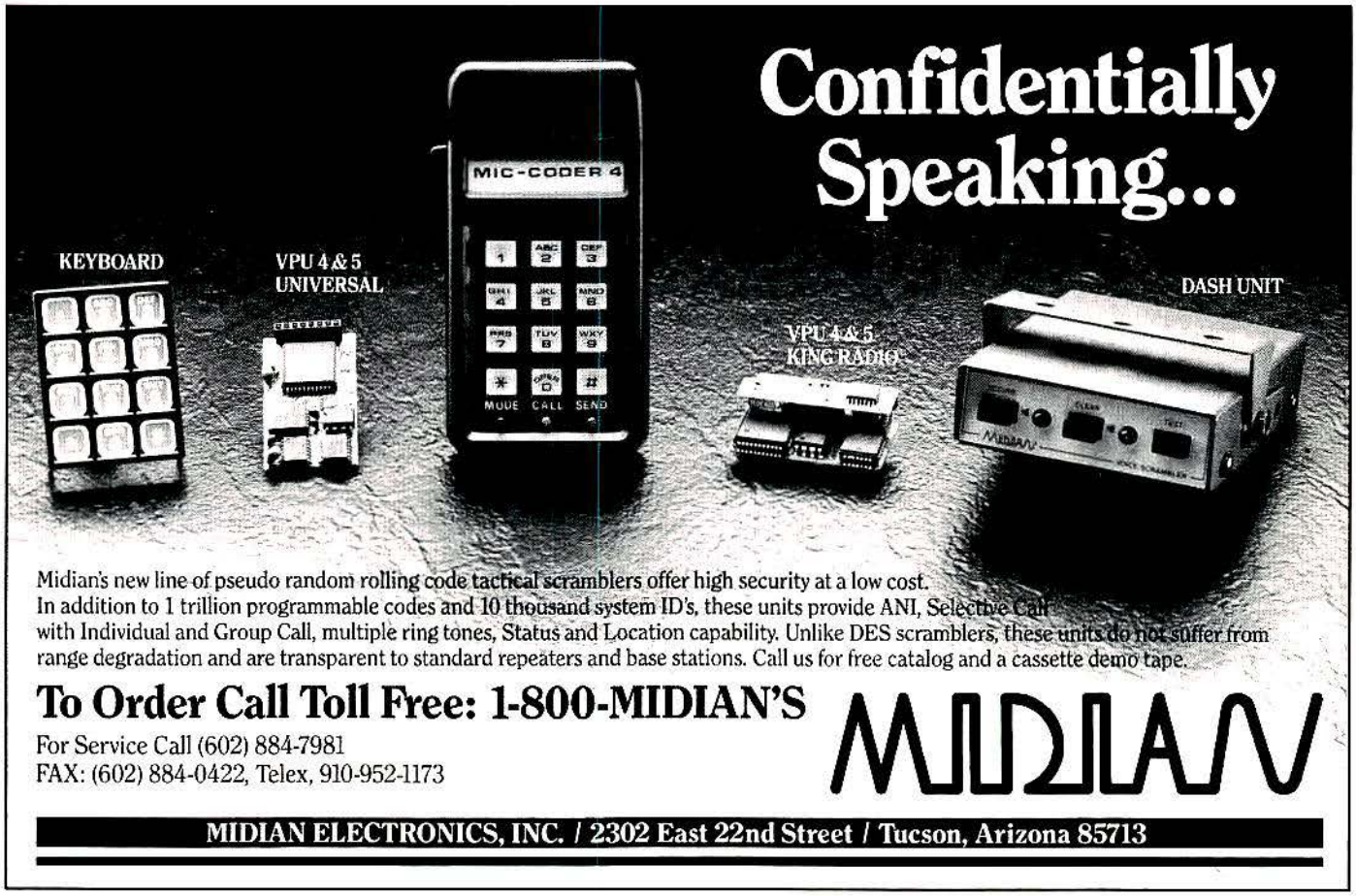
to produce a loop frequency equal to the reference frequency. The loop and reference frequencies are compared in the phase-frequency detector. If they are not equal or not properly phased, the phase detector issues a correction voltage through the UP or DOWN output. The correction voltage causes the charge pump to adjust the VCO steering line control voltage, thus moving the VCO frequency up or down as required to make the loop frequency equal to the reference frequency.

The phase-frequency detector, charge pump and lock detector function exactly as the one described earlier in this article.

In wideband, dual-front-end receivers, the logic level at pin 18 of U115 determines which band is selected. A high on $\overline{S1}$ selects the upper range; a low on S1 selects the lower range.

Logic levels at $\overline{S0}$, $\overline{VCO1}$ and $\overline{VCO2}$ (pins 17, 19 and 20) control the logic circuitry frequency shift. The circuitry controls the VCO frequency's sub-range. (See Table 3 on page 36.)

The steering line control voltage at J1300, pin 10, ranges from +3Vdc to +8Vdc. The VCO frequency depends on the logic levels from the frequency shift logic circuitry and the steering line's dc voltage level. The frequency shift logic



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Table 2—Channel-select codes applied to PROM channel-select address lines.

	(16)	(8)	(4)	(2)	(1)	
CHANNEL	$\overline{E2}$	A6	A5	A4	A3	T/R
1	0	0	0	0	1	1/0
2	0	0	0	1	0	1/0
3	0	0	0	1	1	1/0
4	0	0	1	0	0	1/0
5	0	0	1	0	1	1/0
6	0	0	1	1	0	1/0
7	0	0	1	1	1	1/0
8	0	1	0	0	0	1/0
9	0	1	0	0	1	1/0
10	0	1	0	1	0	1/0
11	0	1	0	1	1	1/0
12	0	1	1	0	0	1/0
13	0	1	1	0	1	1/0
14	0	1	1	1	0	1/0
15	0	1	1	1	1	1/0
16	1	0	0	0	0	1/0
17	1	0	0	0	1	1/0
18	1	0	0	1	0	1/0
19	1	0	0	1	1	1/0
20	1	0	1	0	0	1/0
21	1	0	1	0	1	1/0
22	1	0	1	1	0	1/0
23	1	0	1	1	1	1/0
24	1	1	0	0	0	1/0
25	1	1	0	0	1	1/0
26	1	1	0	1	0	1/0
27	1	1	0	1	1	1/0
28	1	1	1	0	0	1/0
29	1	1	1	0	1	1/0
30	1	1	1	1	0	1/0
31	1	1	1	1	1	1/0
32	0	0	0	0	0	1/0

determines the VCO's frequency sub-range and the steering line's dc level determines the exact frequency at which the VCO will operate within the selected sub-range.

An automatic gain control (AGC) circuit keeps the VCO RF output level fairly constant regardless of frequency. VCO RF output level at pin 1 of J1300 is kept at approximately 400mVrms.

The VCO RF output signal at J1300, pin 1, is buffered by Q190, then directed either to the transmitter exciter or the receiver front end by steering diodes CR190 and CR191, which are controlled by the transmit-receive injection switch, Q191. Another buffer amplifier, Q192, feeds a sample of the VCO signal to the loop divider network input.

The VCO noise filters, Q140 and Q141, provide an extraordinarily clean supply voltage to the VCO circuit at pin 2. This supply voltage must be extraordinarily clean to prevent undesired VCO modulation.

Figure 5 on page 40 shows a simplified diagram of the VCO. The VCO sub-range is changed by using the frequency shift logic to bias PIN diodes on or off. Thus, the PIN diodes are used to connect or disconnect various capacitive and inductive elements to the tank circuit, increasing or decreasing the frequency range. The steering line (at pin 10) connects to varactor diodes, which in turn connect to the VCO's resonant tank circuit.

A change in the steering line voltage causes the capacitance of the varactors to change. This in turn changes the tank circuit resonant frequency. RF output is taken from the tank circuit and amplified by transistor Q1330.

As the receiver IF is 21.4MHz and the mixer uses *low-side injection*, the VCO operates 21.4MHz below the receiver frequency. In the transmit mode, the VCO frequency is equal to the transmit frequency. No multiplication is required except at UHF, where the synthesizer VCO frequency is multiplied by 3 to obtain the desired injection frequency.

Modulation of the VCO is accomplished via a separate varactor diode that also is connected to the tank circuit. Thus, audio signals applied to the varactor diode cause the VCO frequency to vary in step with the audio modulating signal, resulting in *direct* FM.

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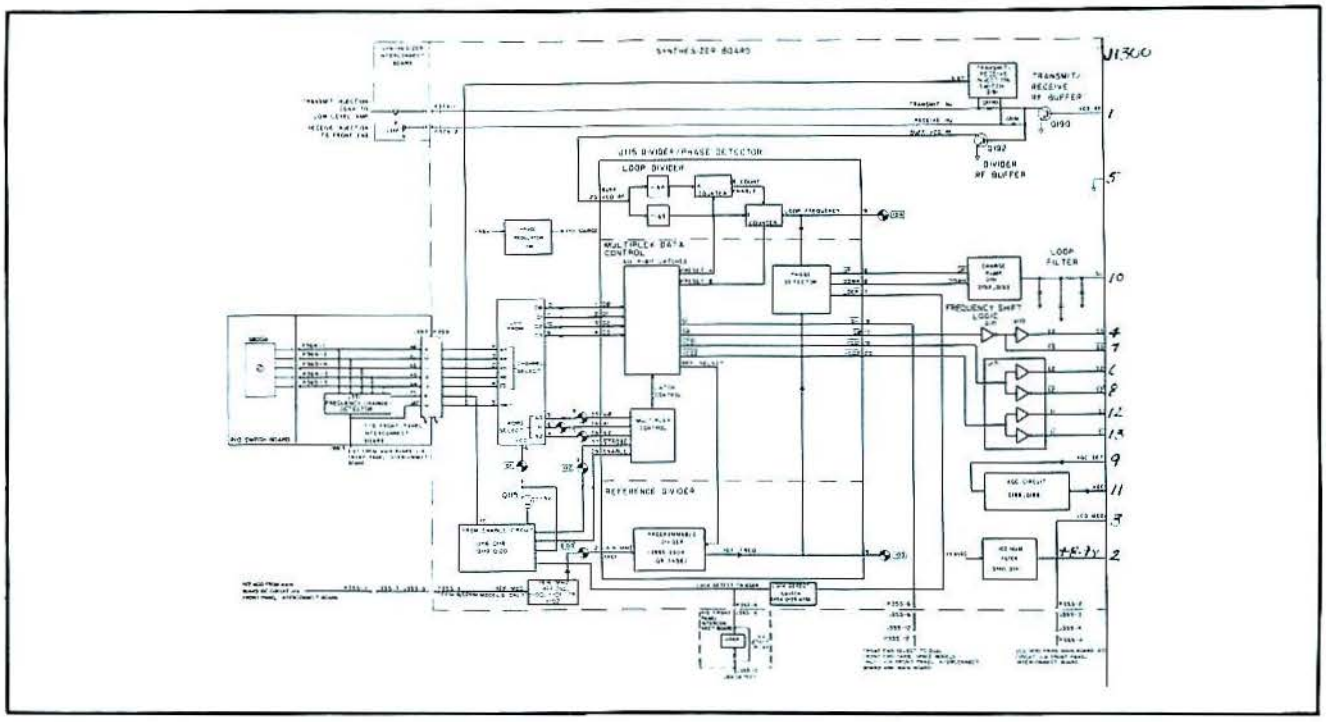


Figure 4. The basic block diagram of the MCX100 synthesizer's digital circuitry, courtesy of Motorola Communications & Electronics.

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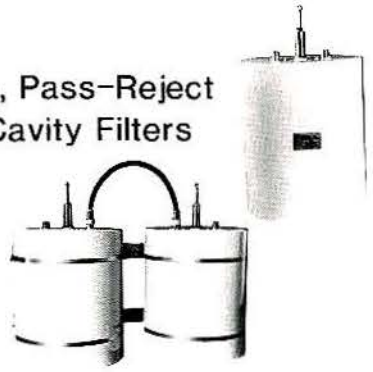
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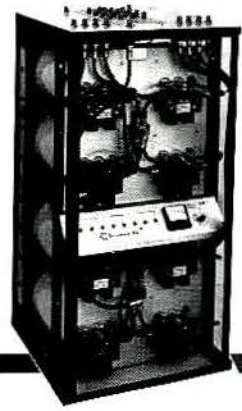
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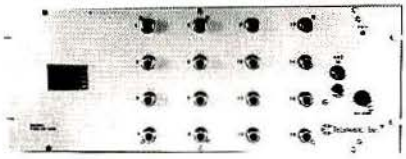
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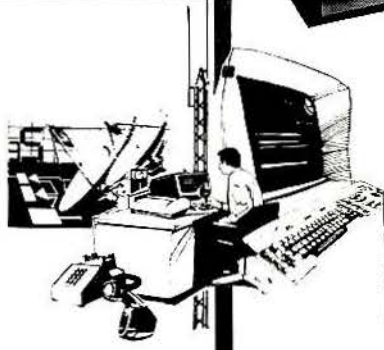




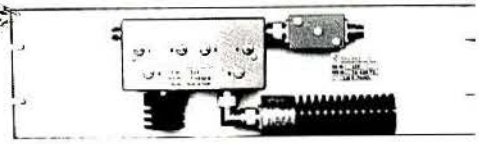
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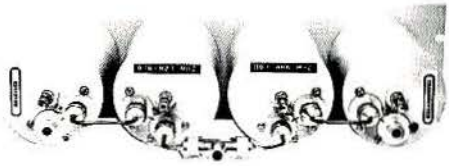


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Table 3—Range-switching logic codes for each of the VCO sub-bands.

RANGE-SWITCHING LOGIC									RANGE II
$\overline{VC01}$	$\overline{VC02}$	$\overline{S0}$	$\overline{S1}$	S1	$\overline{S2}$	S2	$\overline{S3}$	S3	VC0 SUB-RANGE (MHz)
*	0	0	1	0	1	0	0	1	124.6—130.595
0	0	0	1	0	1	0	1	0	130.6—136.795
*	1	0	1	0	0	1	0	1	136.8—142.995
0	1	0	1	0	0	1	1	0	143.0—149.195
*	0	1	0	1	1	0	0	1	149.2—155.395
0	0	1	0	1	1	0	1	0	155.4—161.595
*	1	1	0	1	0	1	0	1	161.6—167.795
0	1	1	0	1	0	1	1	0	167.8—174.0

There are no field-tunable adjustments in the VCO. The transmit and receive frequency adjustments are made by tuning the 14.400MHz reference oscillator frequency. If the reference oscillator is correct, the VCO frequency will be correct—provided the loop is locked and the dividers are programmed properly and functioning properly.

A small error in the 14.400MHz reference oscillator frequency will effect a much greater change in the VCO frequency. For that reason, the reference oscillator must be highly stable and accurate. The amount of change in VCO frequency caused by a change in the reference oscillator frequency depends upon the ratio of the programmable divider (N) to the reference divider.

For example, if the reference frequency is 5kHz, the reference divider is set to ÷2880. If the programmed divide ratio N is 31,854 (as it is for a VCO frequency of 159,270kHz), then the change in VCO frequency is 31,854/2,880 = 11 times the change in the reference frequency. This means that the VCO frequency changes by 11Hz for a 1Hz change in the reference oscillator frequency. Thus, a 100Hz change in the reference oscillator frequency would cause a 1,100Hz change in the VCO frequency.

Reference oscillator frequency adjustment is simple and straightforward. Set the radio to the highest transmit frequency, key the transmitter and adjust the reference oscillator to produce the correct output frequency.

Troubleshooting techniques

The most important troubleshooting point in a phase-locked loop synthesizer is the steering line voltage—J1300, pin 10, in Figure 4. The voltage range on the steering line for this particular synthesizer is +3Vdc to +8Vdc. The dc level should be between these values and should change from channel to channel. If the steering line voltage is above or below this normal range, a problem is indicated.

If the loop frequency F_{LOOP} at the output of the programmable dividers is missing, the steering line voltage will be above the normal voltage range (greater than +8Vdc). If the reference frequency F_R is missing, the steering line voltage will be below the normal voltage range (less than +3Vdc).

It also is important that the steering line voltage be exceptionally clean. Any ripple or ac component on the steering line causes undesirable modulation of the VCO. An oscilloscope should be used to check the purity of the steering line dc control voltage.

Another troubleshooting technique is to disconnect the steering line from the charge pump and to use a suitable, clean, variable dc power supply to drive the steering line. Adjust the power supply output voltage over the normal steering line voltage range while measuring

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the VCO output frequency. The VCO frequency should move through the proper range as the steering line dc voltage is varied.

To insert the power supply voltage, disconnect the steering line from the charge pump. Some radio units provide a jumper that can be removed for this purpose.

A spectrum analyzer is an excellent troubleshooting tool for checking the VCO signal. No physical connection is required—simply use a "sniffer" probe around the VCO circuitry. You may have to remove shields that prevent stray RF leakage from the VCO.

Reference divider output is accessible at pin 5. Loop divider output is accessible at pin 9. Use a frequency counter to check the frequency at these points. The loop frequency at pin 9 (test point 104) always should be the same as the reference frequency at pin 5 (test point 103). A frequency counter and a scope probe can be used to check the VCO frequency at the loop divider network input at pin 25 and the reference oscillator frequency at pin 2. If you cannot get a usable reading on the ×1 probe position, try the ×10 position.

Use a scope to check the loop signal at pin 9 and the reference signal at pin 5. Pulses at these pins are square waves. Reference frequency pulses have a 50% duty cycle. Loop frequency pulses have a much lower duty cycle and vary from channel to channel.

A spectrum analyzer is an excellent troubleshooting tool for checking the VCO signal.

To check the proper operation of the programmable divider network (loop divider), simply divide the input frequency at pin 25 by the output (loop) frequency at pin 9. The result is the divide ratio N of the loop dividers. Remember: The desired VCO frequency equals $N \times F_R$. If the VCO frequency is incorrect, but the N value is correct and the loop is locked, the reference frequency (pin 5) must be incorrect.

An incorrect divide ratio results in an incorrect VCO frequency—the loop may or may not be locked, depending upon the divide ratio N and the VCO frequency range. If the VCO can produce a frequency equal to $N \times F_R$, the loop will be locked. Otherwise, the loop will be out of lock.

If the divide ratio N is incorrect for one or more frequencies, check the PROM, using a programmer to read the PROM contents. If the PROM is good, then it is likely that the divider IC (U115) is defective.

It is possible for one of the latches or one of the programmable dividers to

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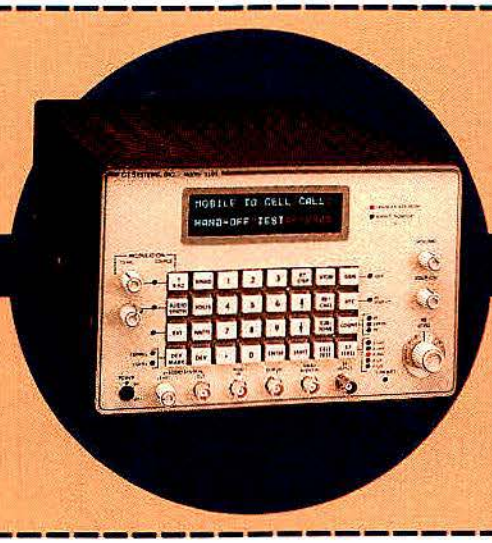
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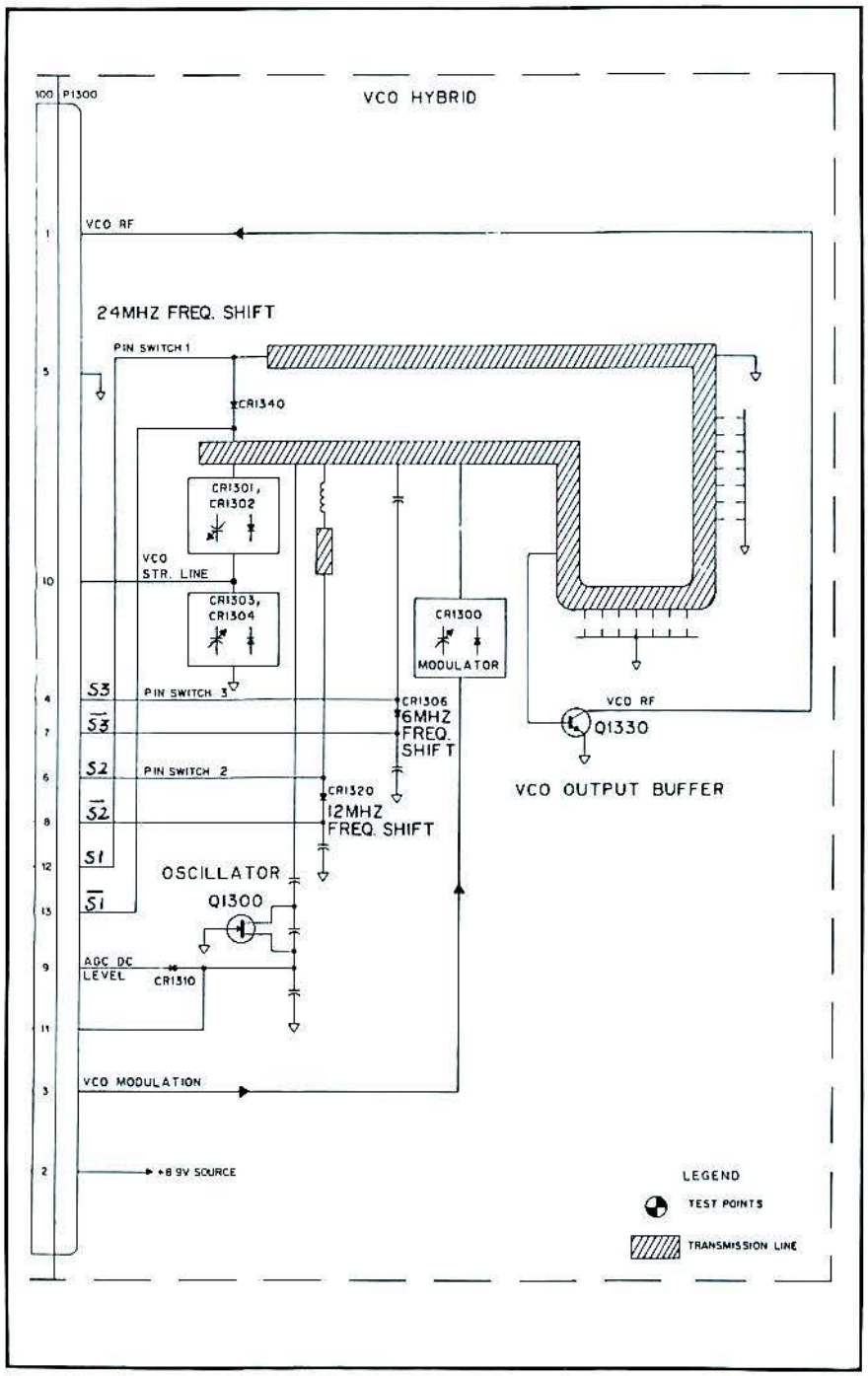


Figure 5. A simplified diagram of the VCO used in the MCX100 synthesizer, courtesy of Motorola Communications & Electronics.

have a "stuck" logic level and still be able to work with certain frequencies but not with others. For example, if one of the latch outputs connected to one of the programming lines is stuck *low*, then as long as the program code for a certain frequency requires a low on that line, it will perform normally. But if the frequency code requires a *high* on that line, it will not be able to force the line high and an improper divide ratio *N* will result.

A logic probe is an excellent tool for troubleshooting this type of digital PLL synthesizer. It is most useful for checking the logic levels around the frequency shift logic circuitry quickly, for checking the channel selector addressing codes and the PROM and for checking the lock detect state. A voltmeter can be used, but it is not as convenient.

Another advantage of the logic probe over the voltmeter is that the logic probe indicates the presence of a pulse at the test point. A high-quality logic probe can detect a pulse whose width is as narrow as 10 nanoseconds.

A logic probe with a pulse indicator can be used to check for data flow across the data bus in this synthesizer. By grounding pin 28, you enable the multiplexer. With the multiplexer enabled, use the logic probe to check for the strobe pulse at pin 27; address pulses on pins 23, 24, and 26; PROM enable pulse on pin 16 (U117); and data pulses on pins 11, 12, 13 and 14 (U115).

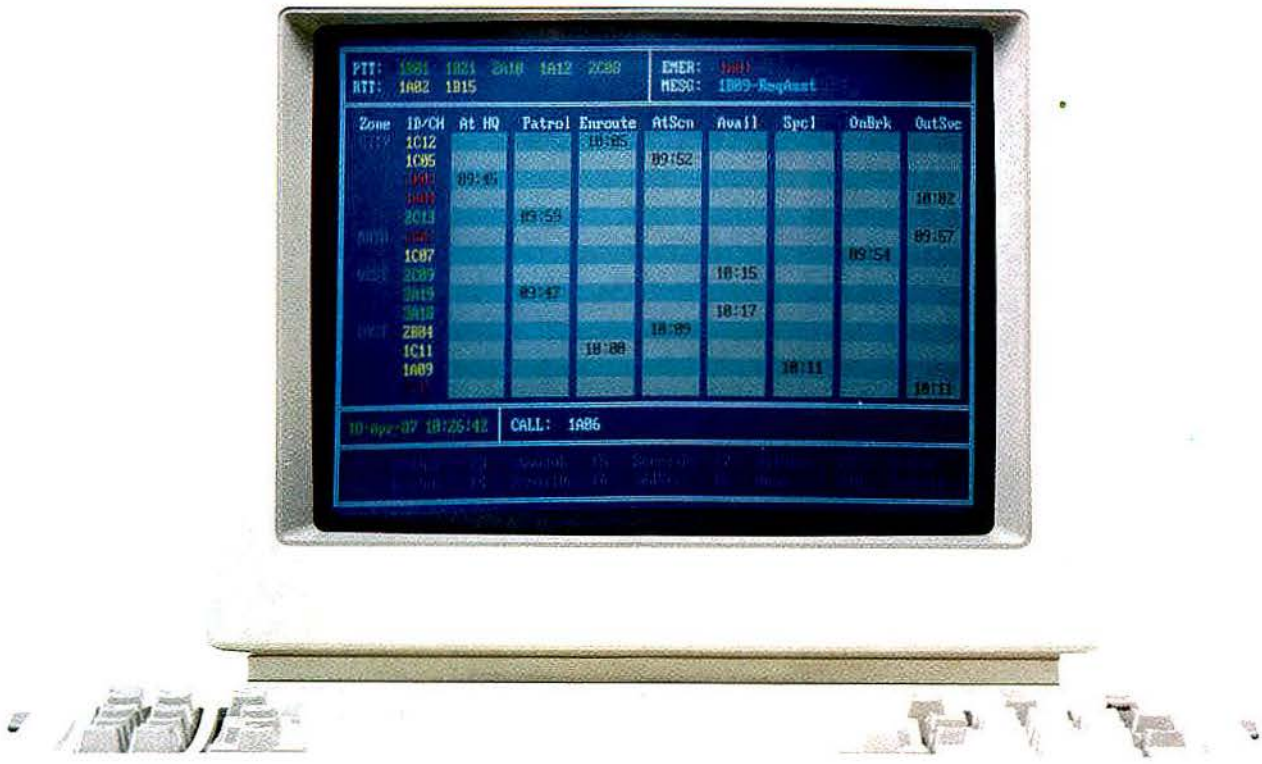
Troubleshooting techniques presented here are not all-inclusive. The techniques you use will be governed by the type of equipment available to you and personal preference.

This article, and last month's installment, have introduced digital PLL frequency synthesizers. After you study this information, you will become more competent and comfortable in troubleshooting these circuits.

But the learning process does not end here. In hopes that your appetite for more information on frequency synthesizers has been whetted, a list of reference is provided.

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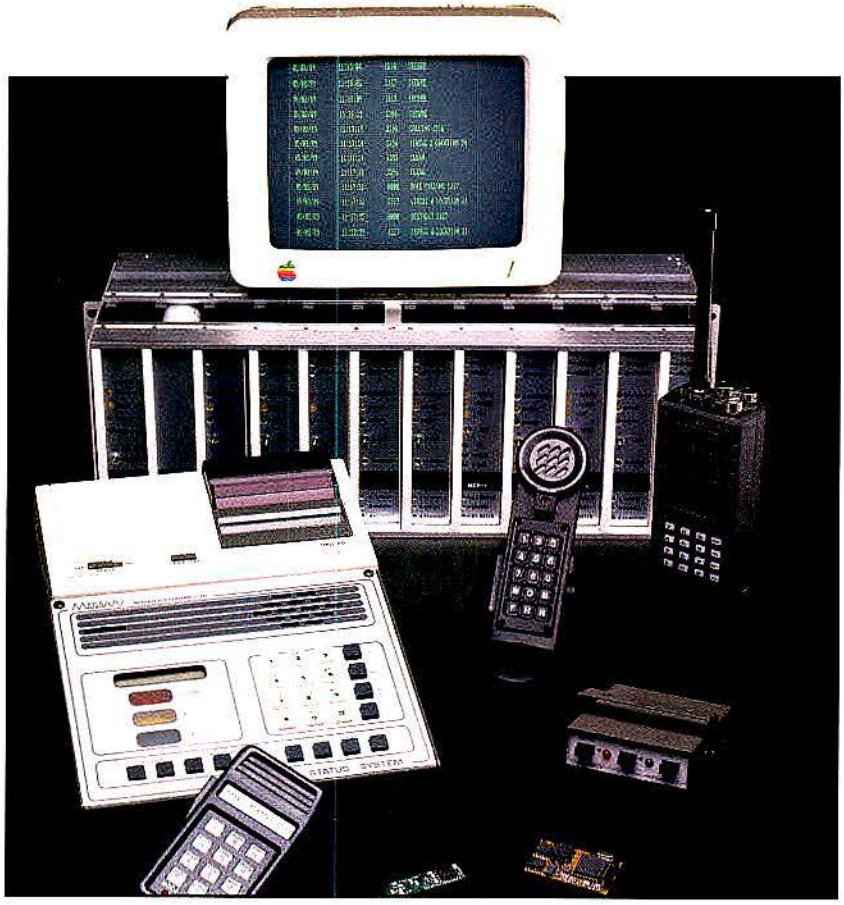
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A rolling code scrambler gathers diverse functions

A 'bit' here and a 'bit' there deliver functions that include system and unit identification, status and location information, selective calling, remote control and telephone interconnect—in what started as a scrambler!

By E.J. McKernan and Bill Scott



Standard and customized units of the production rolling code scrambling system include 'status decoder and display,' 'IMTS system,' 'military handset,' 'microphone' and 'radio modules.'

For centuries, people have attempted to transmit messages over long distances and to protect those messages from unwanted interception.

Until the mid-20th century communicators used ciphers. The sender encoded the message according to a codebook; the recipient decoded the message according to another codebook and a key. The cipher method was time-consuming and codes could be broken.

Early radio communicators who needed to protect messages used ciphers extensively, although ciphers were unsuitable when fast action on the part of the recipient was required.

Advancing technology unveiled other ways to make a message "secure." For voice communication, technology delivered ways to encode ("scramble" or "encrypt") the voice at the transmitter and decode it at the receiver to "clear voice" communication in real time.

Two of the technologies are represented by *frequency domain* and *time domain* scramblers. Time domain scrambling includes time-segment permutation scramblers and digital encryption devices. In the past, these scramblers and encryption devices were bulky and expensive and provided poor audio quality.

McKernan is a systems engineer at Midian Electronics, Tucson, AZ. Scott is president of CommTech, Orlando, FL.

Many people question the actual "level of security" provided by each method. Speech security and voice privacy are important concerns for virtually all military, government, police and commercial radio users. Their anxiety has grown along with the increasingly high level of technology used by criminals and other unauthorized eavesdroppers. (Definitions of "security" and "privacy" appear in the box on page 56.)

Analog scramblers

Two types of frequency domain analog scramblers, inversion and rolling code, deliver different levels of voice privacy.

- *Inversion*—Inversion scramblers offer a practical level of privacy that helps to prevent casual eavesdropping by a listener with a scanning receiver (scanner).
- *Rolling code*—Microprocessor-controlled rolling code scramblers deliver a tactical level of voice privacy. The rolling code scrambler may include other radio communication system functions besides scrambling, such as



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Breaking the code

Generally, the first question a prospective user of a scrambler product asks is: "How long does it take to break the code?"

The answer depends more upon the expertise of the person breaking the code and the equipment used to do it than it does on the scrambler design. Users should avoid transmitting vital secrets by radio over a scrambled circuit because all scrambling codes can be broken. All it takes is time and money.

Each user must evaluate the capabilities of their commercial competitors, criminal adversaries or military enemies who might attempt to receive and decode the user's radio transmissions.

An important factor is *how long it takes* to break the code and "descramble" scrambled radio transmissions compared to the time-value of the information. Most users find that a "tactical" level of privacy is adequate.

Information that would be useless after a certain amount of time passes can be protected adequately by tactical voice privacy because it requires too much time to decode. For example, law enforcement communications intercepted by adversaries might be used in a way that threatens the lives of officers about to take forceful action. But if the communications cannot be decoded quickly, the action takes place before privacy is compromised.

The time it takes to break the code may range from hours to days, depending upon the skill and equipment used by the adversary and the type of tech-



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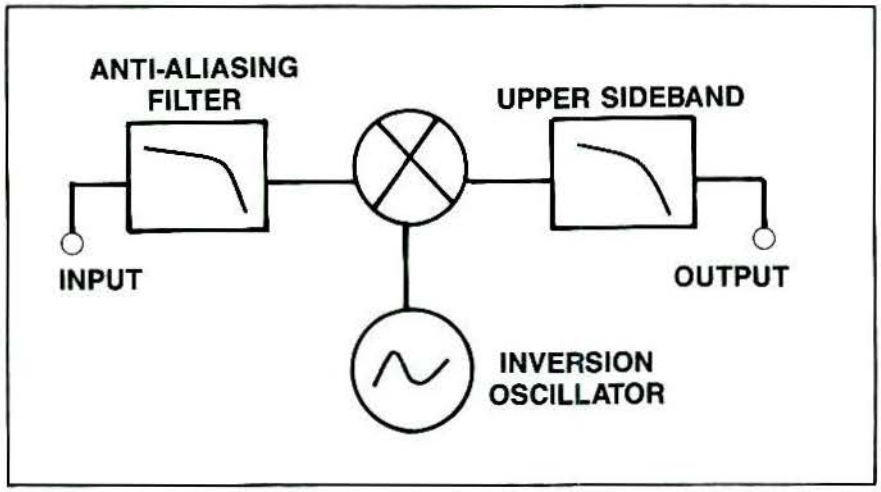


Figure 1. An inversion scrambler block diagram. The anti-aliasing filter removes AF components above the inversion frequency. Remaining audio mixes with the inversion frequency in a balanced modulator whose output includes the sum and difference of audio input and inversion frequencies. An upper sideband filter eliminates the sum frequencies; difference frequencies pass to the output.

nology used in making the scrambler.

Scrambler technology

Figure 1 above is a block diagram of an inversion scrambler. Audio passes through an anti-aliasing filter to remove audio frequency components above the inversion frequency.

The remaining audio is "mixed" with the inversion frequency in a balanced modulator. The balanced modulator output includes the sum and difference of the audio input and inversion frequencies.

An upper sideband filter eliminates the sum frequencies; the difference frequencies pass to the filter output.

For example, if a voice frequency component of 500Hz mixes with an inversion frequency of 3,000Hz, a difference frequency of 2,500Hz appears at the filter output. If a voice component of 2,500Hz mixes with the same inversion frequency of 3,000Hz, a difference frequency of 500Hz appears at the filter output. Thus, the voice audio frequency spectrum is inverted. Figure 2 on page 48 shows the power distribution of voice frequency energy before and after inversion.

Sum frequencies in this instance, 3,000Hz + 500Hz = 3,500Hz and 2,500Hz + 3,000Hz = 5,500Hz, are eliminated by the upper sideband filter.

The anti-aliasing input filter removes all frequencies higher than the inversion frequency to prevent high frequencies

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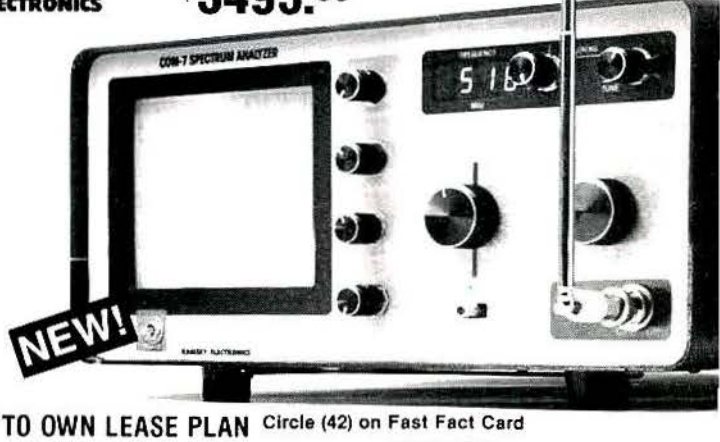
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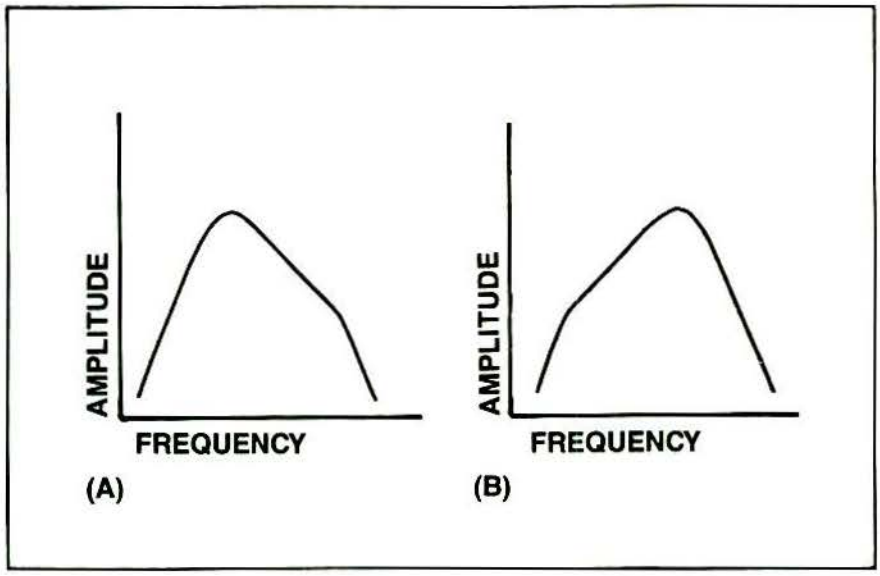


Figure 2. Voice frequency power distribution curves before (A) and after (B) inversion show the upper frequencies have been converted to the lower range and vice versa.

above the normal voice range of 300Hz to 3,000Hz from entering the mixer and generating aliases.

If, for example, a 3,500Hz voice frequency mixes with the 3,000Hz inversion frequency, a 500Hz difference frequency results. When passed through the receiver descrambler, the 500Hz difference frequency is converted to 2,500Hz, not 3,500Hz. The anti-aliasing filter prevents such aliases.

Descrambling is accomplished by feeding the received audio through another inverter with the same inversion frequency—clear audio is recovered.

Optimum inversion frequency

The inversion frequency's optimum range is 2,500Hz to 3,600Hz.

Lower inversion frequencies limit the usable voice range, causing a noticeable attenuation of high frequencies in the recovered audio. Higher inversion frequencies remove higher *and* lower frequencies from the recovered audio.

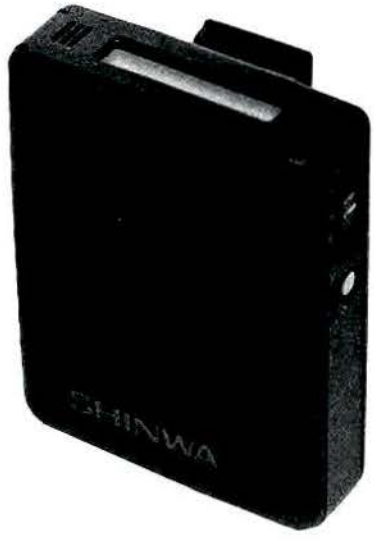
Frequency inverters operating within the 2,500Hz to 3,600Hz range allow the use of about four non-overlapping inversion frequencies, or *codes*.

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output may be applied to one of the four inversion code selection lines. As many as four customers in competing businesses may be assigned a different code.

Adding a fifth code to accommodate five competing customers is impractical because voices scrambled by codes on adjacent inversion frequencies would be intelligible to a listener. A minimum of 300Hz between inversion frequencies must be maintained.

Privacy offered by an inversion scrambler is extremely limited because it is relatively easy for an unauthorized listener to decode in real time. An inverter with a frequency the listener may adjust by hand to match the inversion frequency being used descrambles the communication. Thus, the inversion scrambler's best use is to prevent casual eavesdropping.

Rolling code

A rolling code inversion scrambler is equipped with an inverter whose frequency varies (or *rolls*) between 2,500Hz and 3,600Hz to improve the level of privacy. An unauthorized listener would have to roll a descrambler's inverter at the same rate, range and sequence of frequency changes to intercept the transmission. To descramble a transmission coded by a rolling code scrambler may take so much time that the message eventually decoded may no longer be useful.

In its simplest form, the rolling code scrambler hops through many frequencies in sequence from 2,500Hz to 3,600Hz at a constant rate. In practice, such a scrambler adds little privacy because each transmission follows the same pattern of inversion frequency changes. Once the pattern has been determined by the unauthorized listener, a device based on the repetitive code can be engineered to decipher subsequent conversations.

Placing the inverter frequency under the control of a microprocessor configured as a pseudo random number generator with dozens of injection frequencies improves the privacy level of a rolling code scrambler. The microprocessor sequences frequencies from 2,500Hz to 3,600Hz in a random manner many times per second. The length of time the inverter dwells on any given frequency is controlled in a random manner.

With the microprocessor technique, millions of combinations of frequency and dwell time are possible, greatly improving the scrambling privacy level.

Two more questions about rolling code scramblers:

If both the transmitting and receiving units have rolling code scramblers and they are not on the same inversion frequencies, how are they ever able to hear each other?

If the units roll through the same set of inversion frequencies at the same rate but the moment of change is slightly skewed, won't there be periods when clear speech is heard, mingled with periods of noise?

Synchronization

Communications cannot be conducted

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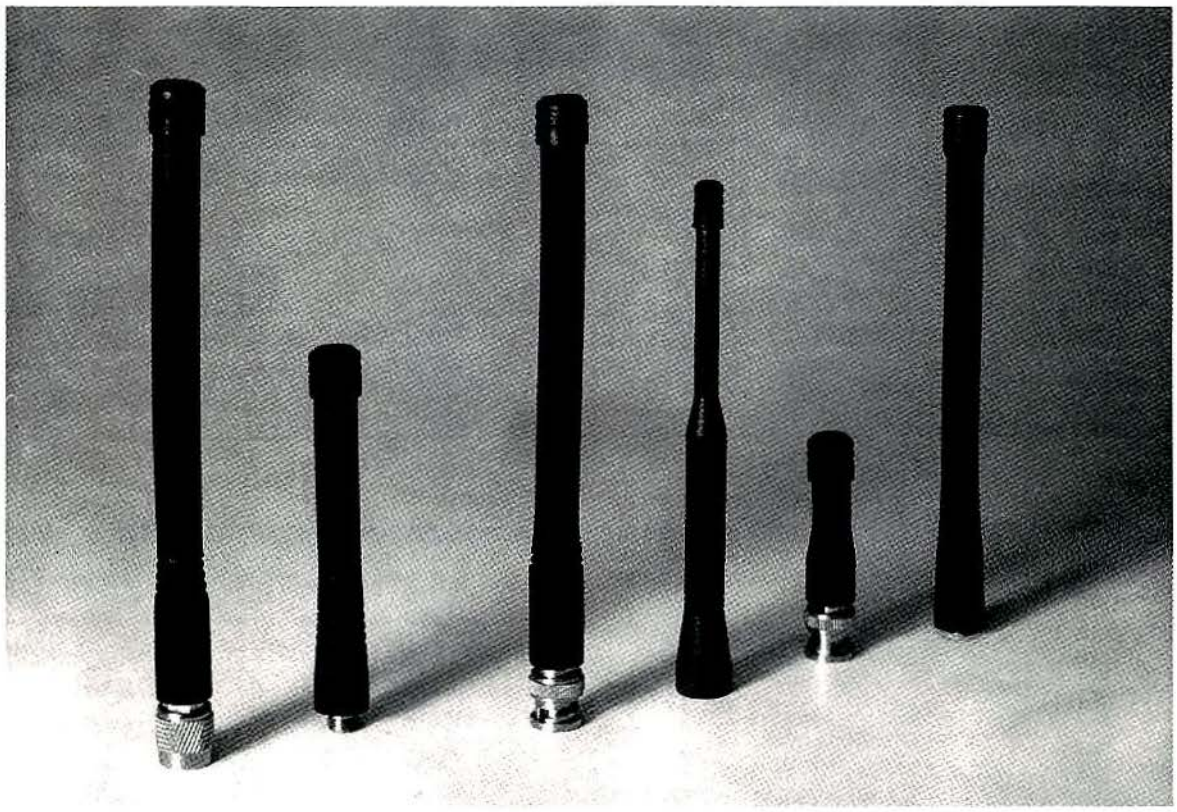
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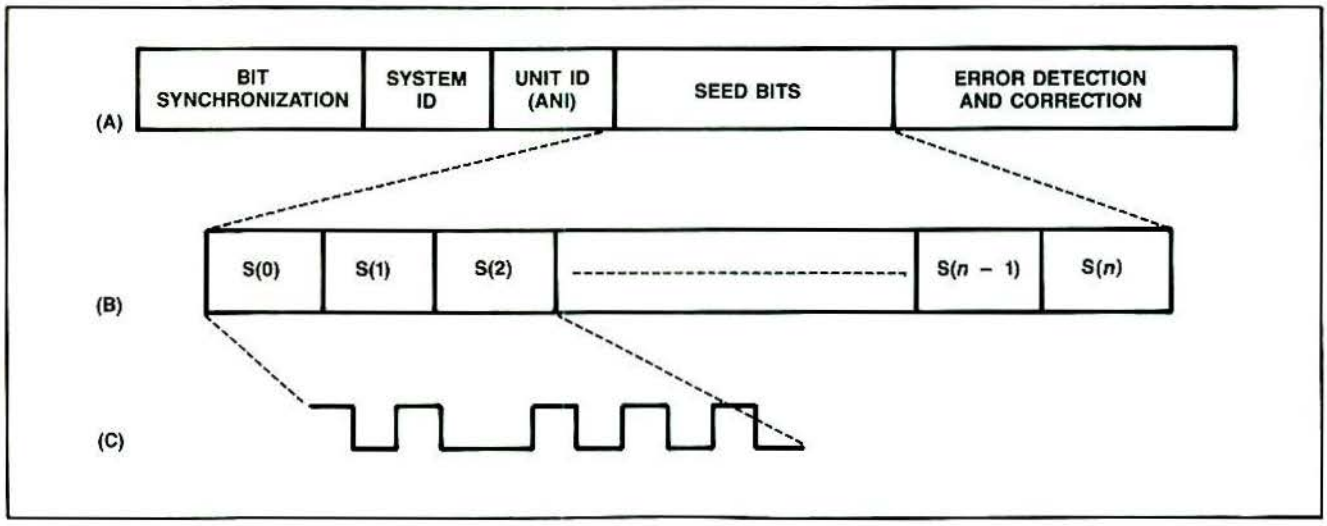


Figure 3. The composition of bits in a data stream used with a rolling code scrambler to increase the privacy level and incorporate a number of additional functions.

under either condition. Therefore, synchronizing the transmitting and receiving units is essential.

Synchronization allows the transmitter to command the receiver to follow in step along a defined sequence of inversion frequencies. Three synchronization methods are RF carrier detection, burst tone and in-band tone.

• *RF carrier detection*—The simplest way to synchronize a receiver is to use its RF carrier detection circuit to start the rolling code sequence. The method works in the laboratory, but signal delays caused by repeaters and voting receivers render RF carrier detection unusable for synchronization.

• *Burst tone*—Another simple syn-

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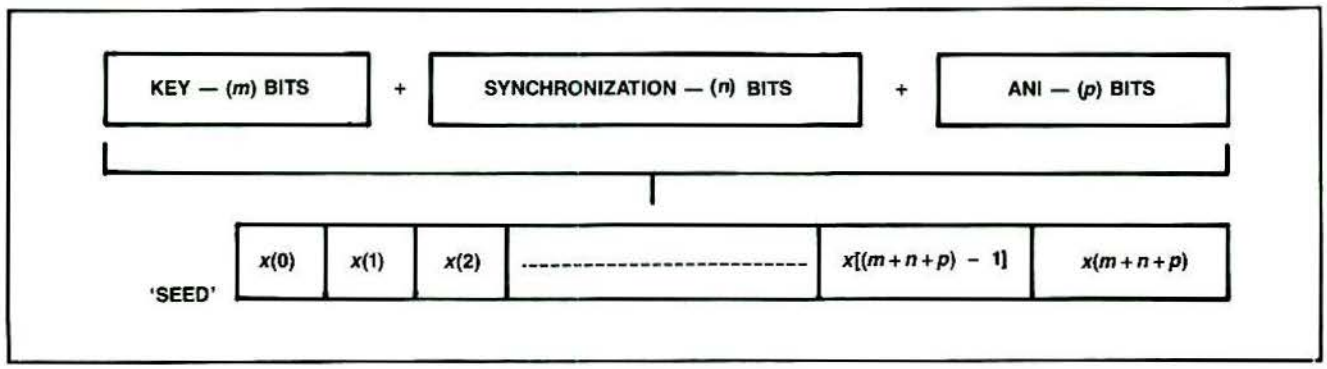


Figure 4. A further improvement to the privacy level uses a 'key' to load into the scrambler through its keyboard, a *keyloader* or, in some cases, over the air. Upon transmitting or receiving a synchronization signal, the scrambler uses the key and bits transmitted in the synchronization stream to form a *seed* for the pseudo random number generator.

chronization method uses a burst tone. Synchronization occurs either when the tone first is detected or when the absence of tone is detected.

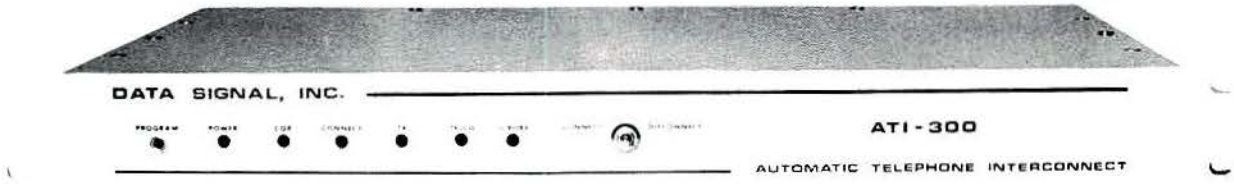
Time required for tone detection poses a challenge. The typical 30ms tone-detection time combined with transmitter codes that change rapidly allows the transmitter to lead the receiver in the tone sequence, defeating synchronization. Moreover, noise renders tone burst synchronization unreliable.

• *Phase shift*—A third method uses an in-band tone to modulate the RF carrier. A single phase shift of the tone serves as the synchronizing signal. Phase shift is easy to detect and it can be done instantly.

Noise causes trouble for the phase shift method. Most phase shift detectors give false outputs under noisy signal conditions.

All three of these methods force the scrambler to start with the same inversion frequency and proceed through the same sequence of tones during each segment of conversation. Once this sequence has been discovered by an ambitious and determined unauthorized

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listener, the system loses its privacy.

• *Data stream*—A method that sends a data stream from the transmitter to the receiver via multiple phase shifts or other modulation vastly increases the privacy level and usefulness of the rolling code scrambler. Figure 3 on page 52 shows the composition of a synchronization data stream.

Additional bits in the synchronization stream serve as additional bits for the pseudo random number generator that chooses the current inversion frequency. With n additional data bits dedicated to synchronization, 2^n discrete starting points are created for the pseudo random inversion frequency generator.

System identification bits may be added to the data stream. The additional bits may be used to prevent intrasystem crosstalk by preventing scramblers used by two customers on the same frequency from responding to one another's synchronization signaling.

More bits may be added to detect and correct errors in the received bit stream. In noisy signal conditions, these bits are essential. Without them, communication is impossible because noise can modify the synchronization, rendering it unreadable at the receiving decoder.

Another improvement in the privacy level involves using a "key" that is loaded into the scrambler through its keyboard, a *keyloader* or, in some cases, over the air. Upon transmitting or receiving a synchronization signal, the scrambler uses the key and bits transmitted in the synchronization stream to form a *seed* for the pseudo random number generator. (See Figure 4 on page 54.)

The unit ANI may be added to the seed to guarantee that no two units ever start the generator at the same point in the rolling code sequence.

If n is the number of bits included in the synchronization stream for the seed; m is the number of bits provided by the key; and p is the number of bits provided by the unit ANI, then a pseudo random number generator $n+m+p$ bits in length can be seeded. A proper pseudo random generator routine thus can provide $2^{[n+m+p]}$ numbers before repeating itself. When $n+m+p$ is sufficiently large, the generator never will repeat the sequence during the life of the product.

Bits can be used to add capabilities to scrambling, such as ANI, status, location and selective calling. When integrated into the scrambling module, these functions save a dealer a lot of time and frustration involved with putting together many discrete boards to provide all the options a customer may desire.

Production unit capabilities

• *System and unit identification*—A production model scrambler that includes those capabilities allows for system and unit identification. The system ID provides for 10,000 distinct systems and guarantees that no two systems will interact with one another.

Unit identification allows for 1,000 separate unit identifications per system. The system and the unit ANI are encoded in the data stream each and every transmission for tracking all system use—and misuse.

• *Status and location*—Status and location bits can be encoded into the data stream. A user can send the current status and location manually via a keyboard. The data are interpreted and displayed by a command console. It also is possible to poll any individual unit for current status and location information.

Status information has a reserved pat-

Definitions

Depending on who does the explaining, definitions of communications security, privacy, encryption and scrambling may differ.

• *Security*—The most stringent description defines a secure radio communication as one that resists detection and jamming. A listener cannot tell whether a secure radio communication is taking place and cannot transmit a signal that would materially interfere with it. A secure radio communication is likely to be encrypted, too. Spread-spectrum modulation offers security but narrowband FM does not.

• *Privacy*—A "private" radio communication is subject to detection and jamming, but its content cannot be converted to a clearly understood voice without decoding equipment. A listener hears the signal and might conceivably jam it and trace it to its source. But without a decoder the listener hears unintelligible sound.

• *Encryption*—The tendency is to use the word "encryption" to describe voice privacy technology based on digital techniques.

• *Scrambling*—Voice privacy techniques based on analog technology tend to be called "scrambling."

The line between encryption and scrambling blurs when digital devices control analog devices in a voice privacy product.

• *Practical*—Voice privacy techniques that offer a lower level of privacy—a "practical level"—stop the casual eavesdropper from overhearing the content of radio communications.

For many commercial applications, one degree or another of practical voice privacy may be sufficient to prevent a competitor from listening.

• *Tactical*—Voice privacy techniques with a higher level of privacy—a "tactical" level—may be used by law enforcement agencies, military organizations and some commercial users. The object is to make the coding so difficult to break that even someone who spends time and money trying will fail in the effort, or take so long that the information revealed is useless.

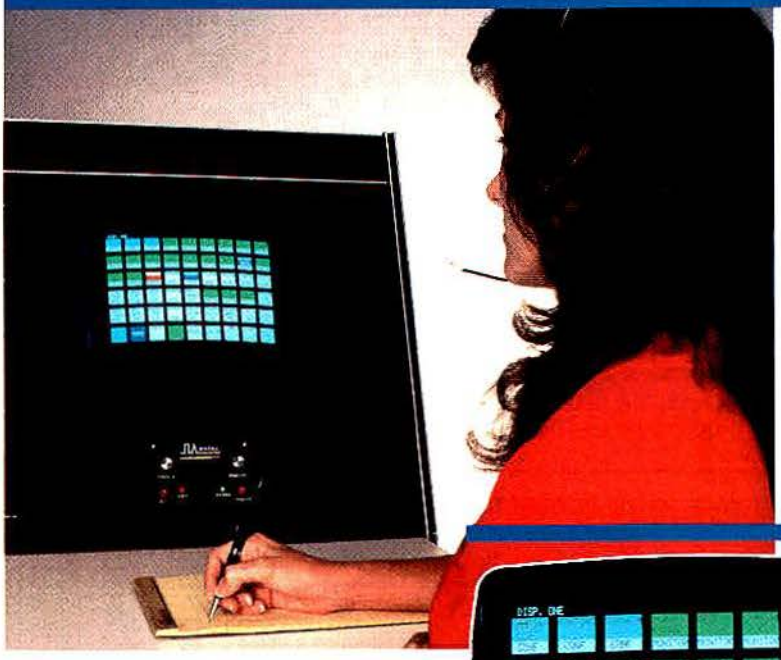
The degree of success attained by any given tactical voice privacy method is difficult to measure. The listener who succeeds in monitoring tactical communications is not likely to tell anyone.

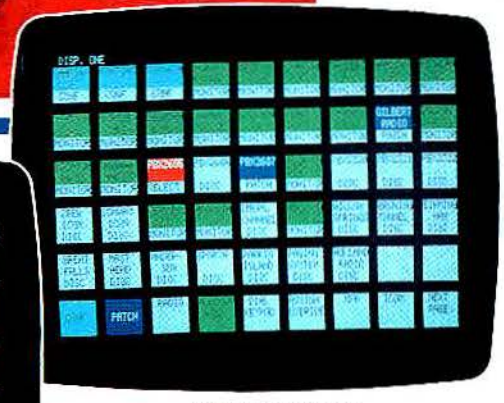
If the listener successfully uses decoding receivers to support illegal activities and evade apprehension, the fact that a law enforcement agency's or a commercial enterprise's radio communication privacy has been broken by that listener may never be confirmed.

Thus, a distinction can be made between "security" and "privacy," and between "practical" privacy and "tactical" privacy.

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tern that is interpreted as an emergency signal. When the emergency pattern is decoded, the system alerts its operator to an alarm indication. The pattern may be sent from the scrambler by manual entry or the activation of a special input. Special inputs that have been used include a foot switch in a mobile unit and a pin lanyard arrangement connected to a hand-held unit.

• *Selective calling*—For selective calling, each unit has four separate decode numbers that any other unit or command console in the system may use to call it. Each of the four decode numbers activates a distinctive ringing sound.

The numbers can be configured as "individual," "group" or "all-call." When called via an individual call number, the unit responds with its ANI, current status and location.

• *Remote control*—The units allow a command console to activate their transmitters. This capability might be useful, for example, when a police officer's radio is stolen. A radio in the wrong hands defeats the privacy of the entire system.

A command console can key the stolen unit's transmitter for a variable length of time. When the transmitter is keyed, radio direction-finding equipment may be used to track it down.

The command console can render the stolen unit useless by commanding it to erase its electronic memory. The individual unit transponds with its ANI and status to verify the memory erasure command.

• *Telephone interconnect*—For telephone interconnect, a device that converts phase-shift keying (PSK) signaling to dual-tone multiple-frequency (DTMF, or Touch-Tone) signaling can be fitted into an existing interconnect system.

To place a phone call, a unit calls a special ID assigned to the converter. The device converts the unit's ANI to DTMF tones and adds any additional digits that the interconnect needs.

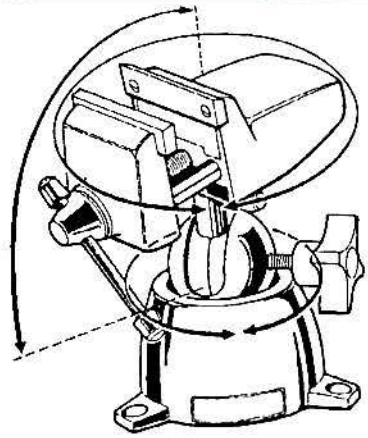
After receiving dial tone from the terminal, the user enters the desired phone number and sends a special dialing stream to the interconnect-converter combination. The converter converts the dialing stream to DTMF tones and feeds them to the interconnect.

When the conversation is finished, the special ID assigned to the converter is called once again. The converter sends a positive disconnect command to the terminal and is ready for another call.

Custom units

The system boasts flexibility. Custom units have been developed that include a full-duplex version for an improved mobile telephone service (IMTS) system and for a cellular telephone system.

A special system for a military man-pack handset includes a 6-digit and an 8-digit map coordinate and advanced status transmission protocol. With digital map coordinate transmission, a field unit can encode its location or that of an adversary and request an air strike, mortar attack or any other predetermined action by using a status protocol.



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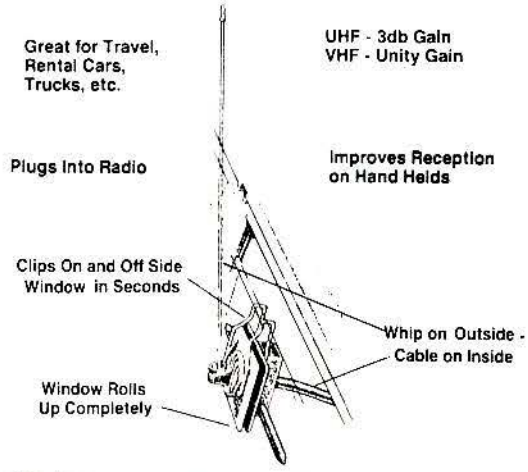
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Piher introduces the CM13 series switch in a ½ inch diameter.

- allows for 16 positions at 22.5° and 8 positions at 45°
- variety of gray and binary codes are available
- shaft seal protects against moisture

PIHER

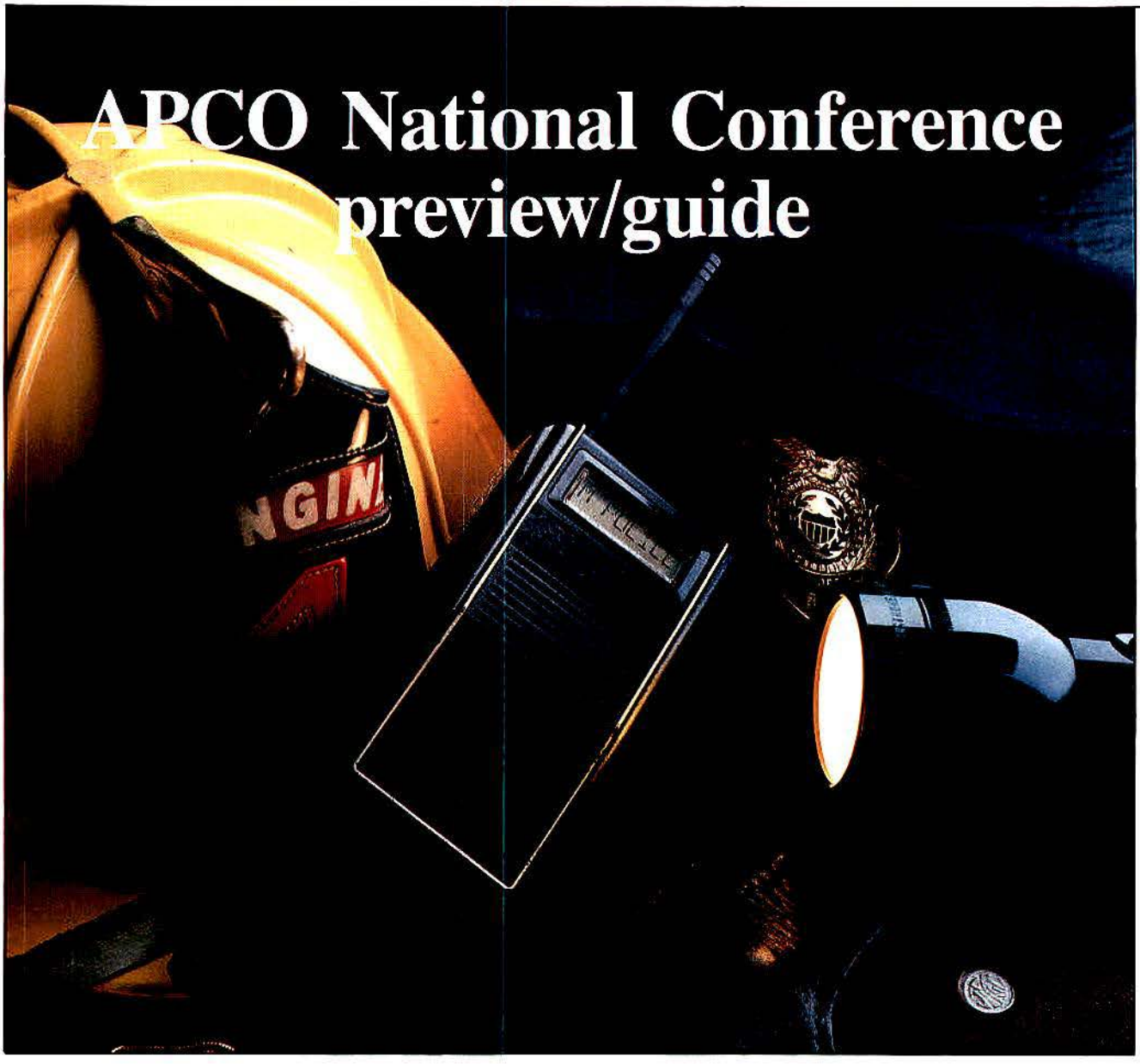
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Member of NACESA Group

Circle (56) on Fast Fact Card

APCO National Conference preview/guide



The 55th annual Associated Public-Safety Communications Officers national conference promises exhibits on all types of land mobile communications: mobiles, portables, mobile data terminals, computer-aided dispatch, antennas, test equipment, batteries, logging recorders and more.

The conference runs Aug. 6-10 in Sparks, NV, at John Ascuaga's Nugget and includes technical sessions. For a rundown on session topics and scheduling, refer to page 64.

Use this preshow guide as a source for information on products and services that will be on exhibit. The preshow guide includes information that was available as of press time.

The names of companies that are advertising in this issue are highlighted in blue ink for quick reference in the exhibitor list and in the products/services section.

Use the show floor map on the right, in combination with the exhibitor list complete with booth numbers, to find companies' booths at the conference.

Event: Associated Public-Safety Communications Officers National Conference
Dates: Aug. 6-10
Location: John Ascuaga's Nugget
City: Sparks, NV
Number of Exhibitors: 185
Projected Attendance: 4,000
Exhibit Hours: Tuesday, Aug. 8, 10 a.m. to 7 p.m.
Wednesday, Aug. 9, 10 a.m. to 4:30 p.m.
Thursday, Aug. 10, 8 a.m. to noon
Seminar Schedule: Monday, Aug. 7, 1 to 5:45 p.m.
Tuesday, Aug. 8, 8 a.m. to 5 p.m.
Wednesday, Aug. 9, 8 a.m. to 4 p.m.
Thursday, Aug 10, 8 a.m. to 4:30 p.m.
Registration/Hotel Information: 800-824-1850

Exhibitors

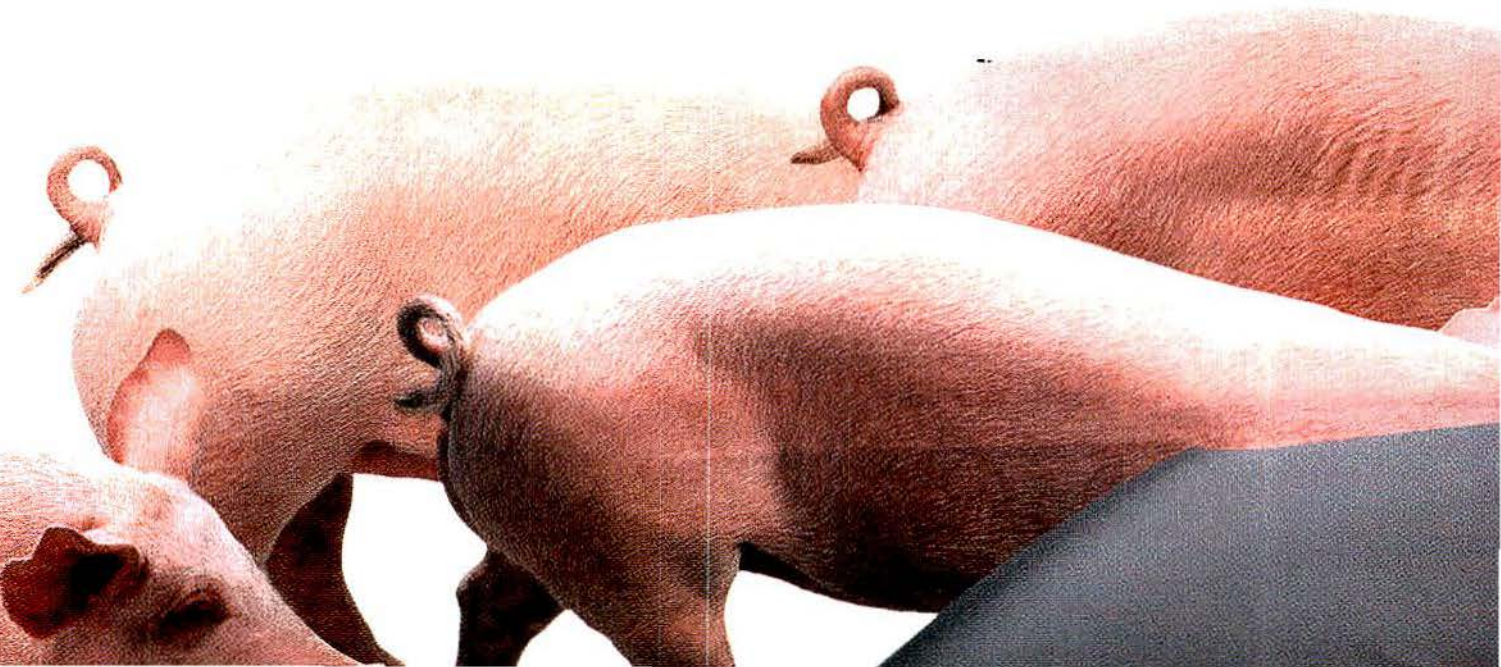
AT&T (611, 613)
AT&T Technologies (615, 617)
Aerotron (334)
Agilis Corporation (1017, 1019)
Alexander Batteries (606)
AM/Comm Systems (113)
Andrew (223)
Antenna Specialists (504, 506)
Atis (1020)
Audio Data (232)
Avtec (119, 121)
Bally Engineered Structures (227)
Bendix/King (214, 216)
Bomar Crystal (900)
Bull (520, 522)
CAD Associates (341)
Cellular Business (Publications bin)
Celwave (306)
Centurion International (328, 330)
Cisco (442)
Coded Communications (95)
Command Data Systems (703, 705)
Com-Ser Laboratories (217)
Communications Associates (444)
Communitech (809)
Computer Resources (131)
Comtronics (93)
Console Systems (208)
Coopers & Lybrand (99)
CT Systems (323)
Dantel-Lac (116)
Dataradio (145)
Dataphase (97)
Decibel Products (516, 518)
DiComm (133)
Dictaphone (508, 510)
Digital Microwave (1007, 1009)
Dinet (427)
DTI (219)
Dynatech Tactical Communication (436)
E. F. Johnson/Philips (501)
ElectroCom Automation (208)
EmergiTech (1010)
Energy Concepts (301)
FailSafe Magnetics (1000)
Federal Signal (608, 610)
Flash Technology (528)
Flour Daniel (802)
Fujitsu Ten Corporation of America (623, 625)
Gamber-Johnson (319)
General Electric (500)
• GTE Cellular Communications (326)
GTE Information Services (318, 320)
Hadron (218)
Hamilton Sorter (135, 136)
Harris Farinon (419)
Harris Lanier (425)
HCS Telecommunications (234)
Heischman Company (539)
Hughey & Phillips (147)
ICM Communications (329, 331)
ICOM America (619, 621)
IFR Systems (314)
Infocel (821)
Informer Computer Terminals (229)
Integrated Computers Concepts (903)
Intergraph (1021)
ISC Cardion Electronics (413)
Kenwood USA (123, 125)
Kustom Electronics (512, 514)
Larsen Electronics (321)
Lightning Eliminators and Consultants (810)
Lucas Ledex (808)
Magnasync/Moviola (415)

A NEW LITTLE PIGGY

There's a new pigtail in town: The all new Larsen® KG-825 On-Glass Cellular Antenna.

It's sleek. Sexy. With a high-tech European look designed for performance as well as appearance — distinctively more elegant than its competition. The KG-825 also sports a small "footprint" which conforms easily to the erratic curves of today's automobile glass.

Technically speaking, the KG-825 is the most advanced antenna we've ever made. We've placed its patented* impedance-matching circuitry on the outside of the glass with the radiating element, creating a low impedance power transfer through the glass. No tuning is required.



Magnavox/Nav-Com (818, 820)
Magnum Distribution (225)
MaSys (312)
Matthews Buses (120, 122)
Maxon Electronics (601, 603)
McDonnell Douglas Computer (87)
METS (226, 228)
Micro-Quick (542)
Microwave Networks (107)
Midland International (240)
Mobile Data International (627, 629)
Mobile Mark (1014, 1016)
Mobile Radio Technology (Publications bin)
Modular Communications (335)
Motorola Radio (600)
Multiplier Industries (710)
MX-COM (322, 324)
NCR Corporation (720)
NEC America (823)
Orbacom/Birham Industries (541)
Pacific Bell (524)
Panvise (901)
Penta (127)
Phoenix Audio Communications (905, 907)
Plant Equipment (201)
Platt Luggage (445)
PolyPhaser (115, 117)
Positron Industries (222, 224)
PRC Public Management Services (700)
PSW3 (325, 327)
Public Safety Systems (438, 440)
Quintron (303)
Radiation Systems (337)
Radio Systems (337)
RAM Communications Consultants (822)
Repco (812, 216)
Rohn (340)
Ron Ross and Associates (1012)
Scala Antennas (714)
Schlumberger Instruments (128)
Setcom (118)
SFA (712)
Shinwa Communications of America (132, 134)
Shure Brothers (902, 904)
Sigtone (1005)
Sinclair Radio Labs/Sinclabs (709)
Solid-State Communications (401, 403)
Spectracom (1008)
Spilsbury Communications (800)
Stancil (713)
Standard Communications (1013)
Starkey Labs (909)
Sti-Co Industries (607, 609)
Syntonic (143)
Systems Concepts of Colorado (535)
Tait Electronics (233, 235)
Tandem Computers (533)
Teletec (146)
TPL Communications (302)
Transcrypt International (1015)
TX RX Systems (429, 431)
Uniden Corporation of America (109, 111)
Unisys (1001, 1003)
U S Commlink (911)
U S Telecom International (108)
US West Enterprises (537)
V Band Corporation (300)
Valmont Industries (129)
Vega (614)
ViaSat Technical (1011)
Vision Technologies (318, 320)
Whelen Engineering (631)
Yaesu (110)
Zetron (706, 708)

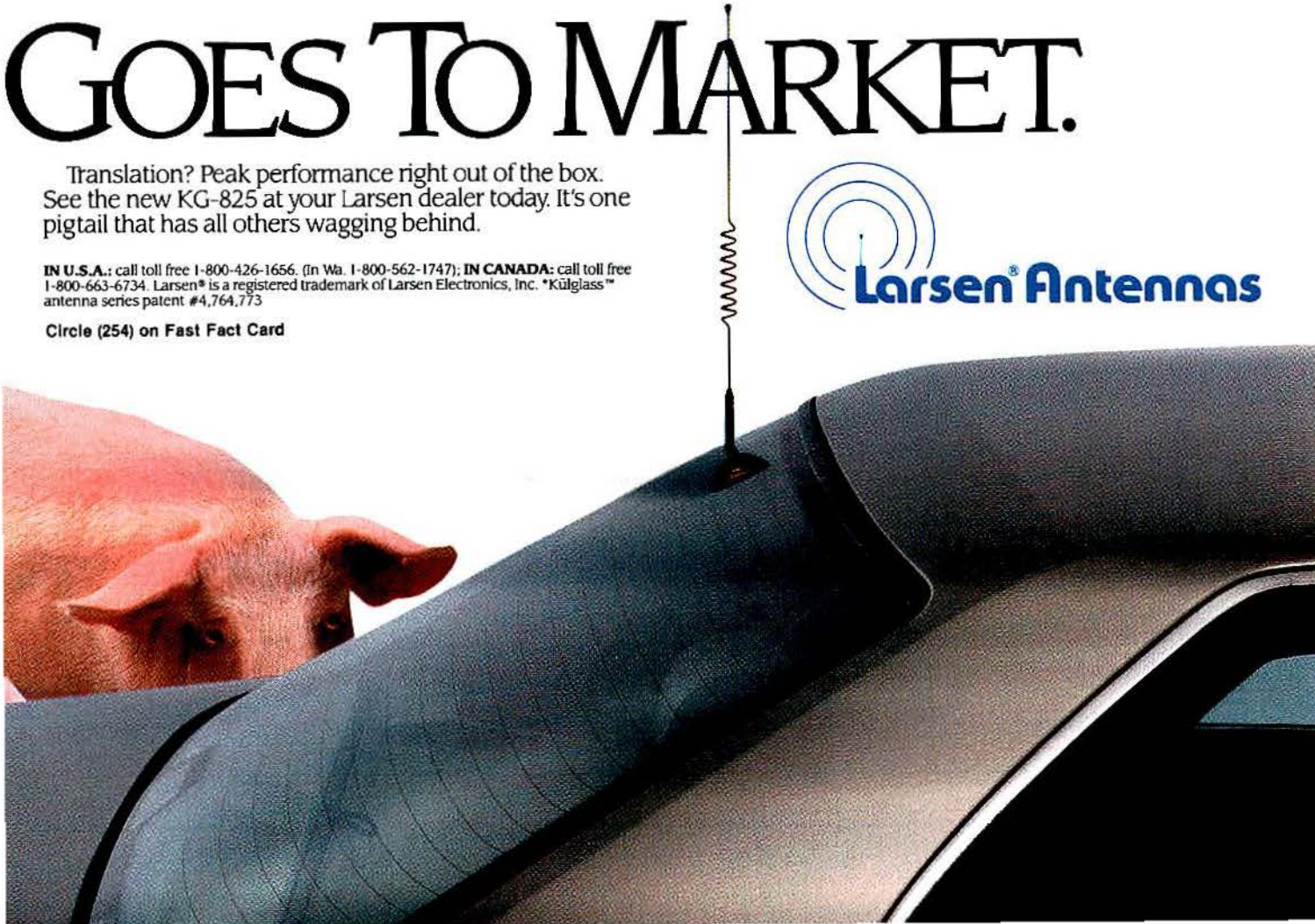
GOES TO MARKET.

Translation? Peak performance right out of the box. See the new KG-825 at your Larsen dealer today. It's one pigtail that has all others wagging behind.

IN U.S.A.: call toll free 1-800-426-1656. (In Wa. 1-800-562-1747); **IN CANADA:** call toll free 1-800-663-6734. Larsen® is a registered trademark of Larsen Electronics, Inc. *Külglass™ antenna series patent #4,764,773

Circle (254) on Fast Fact Card

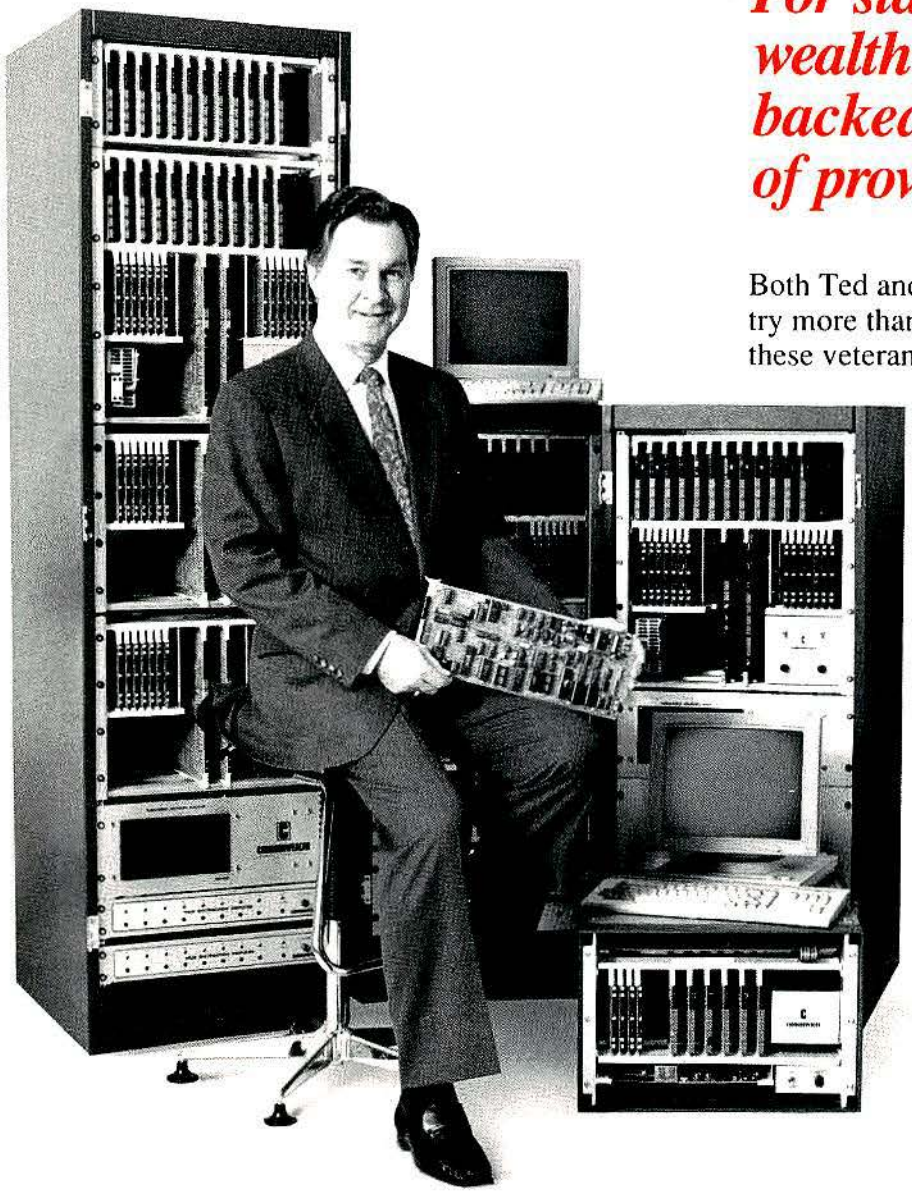
Larsen® Antennas



Session Guide

DAY	TIME	John Ascuaga's Nugget ROOM	TOPIC
Monday, Aug. 7	1-3 p.m.	Celebrity	Washington Regulatory Review Panel
		Southern Pacific D	Transition to Supervision
	2:30-3:30 p.m.	Southern Pacific E, F	Law Enforcement TV Network
	3:15-5 p.m.	Celebrity	Major Issues Facing State Governments
	3:15-5:45 p.m.	Southern Pacific D	Understanding Your Supervisor
Tuesday, Aug. 8	8-9:45 a.m.	Southern Pacific	Optimizing Simulcast
		Southern Pacific A, G	Advanced Trunked Communications Systems
		Southern Pacific C	Microwave Propagation
		Southern Pacific B	Disaster Communications Plan — Restoration
	8-10 a.m.	Southern Pacific D	Tech Talk For Dispatchers
	8:30-10 a.m.	Celebrity	APCO Institute Report
	1-2 p.m.	Celebrity	Interoperability Panel
	1-3:30 p.m.	Genoa	Psychological Testing — Telecom
	1-5 p.m.	Southern Pacific D	Managing Number 1
	2-3 p.m.	Southern Pacific B	9-1-1 Call Volume Monitoring
	2-3:30 p.m.	Southern Pacific E	Selecting Public Safety Communications
		Southern Pacific C	Volunteer in Emergency Communications

What Do Ted Faust And The Mark Series Have In Common?



For starters, a common wealth of experience—backed by a track record of proven reliability.

Both Ted and Commonwealth entered the industry more than a quarter century ago. Together these veterans have helped shape the future of the communications industry.

Whether you begin with our MARK I start-up equipment for up to 1,000 subscribers or the MARK II for up to 2,000 subscribers—or you select the MARK IV or our top-of-the-line MARK VI for up to 10,000 subscribers, you can count on proven performers.

If you need quality service to your customers coupled with cost-effective and reliable operations, we'd be happy to rush you one of our MARK series units.

Let us tell you about our MARK series. Call Commonwealth at (800) 633-8844.

Now DOC approved to CSO_3

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COMMUNICATIONS INDUSTRIES, LTD.

602 Lickinghole Road/P.O. Box 312, Ashland, Virginia 23005
(804) 798-9128, Fax # (804) 798-5114, (800) 633-8844

Circle (60) on Fast Fact Card

Session Guide

DAY	TIME	John Ascuaga's Nugget ROOM	TOPIC
Tuesday, Aug. 8	2-3:30 p.m.	Southern Pacific F	Digital vs. Analog Microwave
	2-5 p.m.	Southern Pacific A, G	Selecting Transmission Cable
	3:45-5 p.m.	Southern Pacific C	Private Telephone Systems
		Southern Pacific F	Digital Speech Encryption
		Southern Pacific B	Video Court Arraignment
Wednesday, Aug. 9	8 a.m. - noon	Southern Pacific D	Managing Number 1
		Genoa	Critical Incident Debriefing
	TBA*	TBA*	Overview of APCO Institute Program
	TBA*	TBA*	Institute Program & Instructor Workshop
	9:45-11 a.m.	Southern Pacific C	Advanced Conventional Communication System
		Southern Pacific A, B, G	Automated System Criminal Justice Management
		Southern Pacific E	Cellular Antenna Systems
	1-4 p.m.	Celebrity	Galaxy Airlines Crash
Thursday, Aug. 10	8 a.m. - 5 p.m.	Southern Pacific D	Train the Trainer
	1-2 p.m.	Celebrity	APCO Delegation to Mainland China
	2-4:30 p.m.	Genoa	Your Management Characteristics

*TBA—To be announced.

CELWAVE

BASE STATION ANTENNAS • CABLE & CONNECTORS • DUPLEXERS

1-3 Day Delivery Nationwide!

$35 FREIGHT WILL DELIVER A BASE STATION ANTENNA AND UP TO 250 FEET OF 7/8" CABLE IN 1-3 DAYS!



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COMMUNICATIONS COMPANY

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513-489-1755

Circle (63) on Fast Fact Card

Products and services

For more information on the products and services listed, fill out and return the Fast Fact Card on page 115. See example below.



XYZ Corporation **Booth 7000**
Existing services
Galaxywide paging, satellite rental, multilingual billing formats.
New Products
Coin-sized pager.
See ad page 310 **Circle 900**

Information listed was accurate at press time and is subject to change.

Aerotron **Booth 334**
Existing products
Mega-E FM mobiles; PAC-2 portables; Concept-E FM mobiles; Mpac base and repeater stations.
New products
Lancer-M VHF FM mobile radio; Pioneer 2000 synthesized ACSB mobile.
Circle 137

Agilis **Booths 1017, 1019**
New products
80C88 mobile network computer and MS-DOS compatible mobile data terminal; 80386 mobile workstation; LCD touchscreen; high-speed radio LAN.
Circle 148

Alexander Batteries **Booth 606**
Existing products
Replacement nickel-cadmium batteries for two-way hand-held radios and pagers; antennas for two-way radios and pagers; battery chargers and analyzers; mercury batteries for pagers; batteries for medical, video and cellular equipment.
New products
Replacement batteries for GE MPD, PLS, TRX, E. F. Johnson LX, Trom H/U series, Motorola MX300/MT1000, Motorola HT600, Motorola Radius series, Motorola Saber series, Midland 70-155 series, Standard HX400 radios, Nokia Mobira Cityman 5000 cellular phones, Motorola 8000 and 9500 series cellular phones
Circle 162 See ad page 38

Andrew **Booth 223**
Existing products
Coaxial cables and waveguides; microwave antennas and systems; cell-site systems; towers; shelters; program management delivery and installation; slotted coaxial cable.
New products
Coaxial cable cutting tools.
Circle 125

Avtec **Booths 119, 121**
Existing products
Access System—color, touchscreen, integrated



MOBILE ADAPTER for the 800 MHz and UHF King Portable
NOW WITH DTMF ACCESSIBILITY!

FEATURES:
- Built in RF amplifier 15 watts-800 MHz 20 watts UHF
- Built in audio amplifier
- External audio jack
- Fast charger
- All connections made with one sliding lever
- Keylock for security
- Constructed to compliment the King Radio line
- Complete with microphone and mounting bracket

Leadership by Tradition
talk power by TPL COMMUNICATIONS, INC.

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FAX (213) 254-3210

Circle (57) on Fast Fact Card

ORBACOM SYSTEMS, INC.

THE ORBACOM® CALIDA™

Self-contained (no Central Package) with 16-channel capacity. It has a multi-format internal paging and signalling encoder and is fully user-programmable.



THE TDM-150 DISTRIBUTED MICROPROCESSOR CONSOLE



This control center is the advanced technology answer to your dispatching needs for systems of varying degrees of size and complexity.

Tower Industrial Complex
450 South Fellowship Road
Maple Shade, NJ 08052
(609) 482-1155 • FAX: (609) 482-2710

Circle (58) on Fast Fact Card

radio dispatch consoles compatible with E-911 systems.
Circle 124 See ad page 57

Bally Engineered Structures **Booth 227**
Existing products
Preassembled modular structures.
New products
Bally will be conducting tours of its Sparks, NV, plant.
Circle 168

Bendix/King **Booths 214, 216**
Existing products
VHF and UHF portables; VHF mobiles; 800MHz portables and mobiles.
New products
Controller I, II and III computer-aided dispatch systems.
Circle 176

Cellular Business **Publications bin**
Existing products
Cellular Business is the "Journal of Cellular Telecommunications" and the official publication endorsed by CTIA. It is published monthly and provides marketing and engineering information and news of the cellular industry. Readers are cellular professionals, including wireline and non-wireline cellular systems operators, dealers, agents, resellers, engineers and members of the telecommunications financial and legal communities.
Circle 170

Celwave **Booth 306**
Existing products
Base station antennas; RX multicouplers; TX combiners; filter products; duplexers; portable antennas; Glass Advantage glass-mount antenna.
New products
Penetrator beam-tilt and null-fill antenna; Cellular Advantage tri-band antenna.
Circle 163

Centurion International **Booths 328, 330**
Existing products
Manufacturers of antennas and batteries for portable two-way radios, scanners and cordless telephone equipment; supplier to OEMs of specialized products for custom applications.
New products
Replacement batteries for the Motorola line, including: Radius P10 (PR5044), Radius P50 (PR9027), Radius P200 (PR5521), HT600 (HT4585), MT1000/MTX800 (MT4824).
Circle 106 See ad page 33

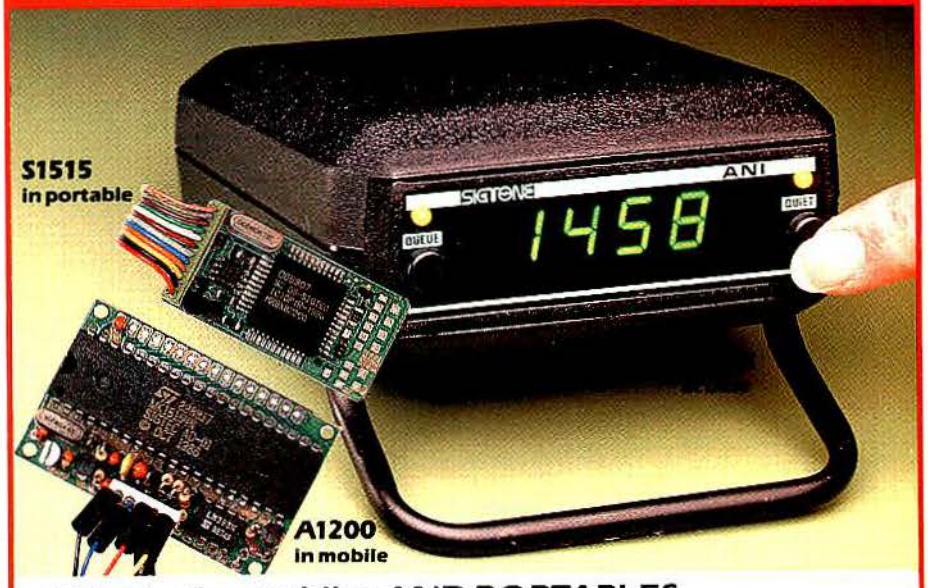
Coded Communications **Booth 95**
Existing products
System 1040 computer-aided status display dispatch system.
New products
9200 mobile data terminal.
Circle 109 See ad page 41

Communications Associates **Booth 444**
Existing products
IFR test equipment; Regency and Yaesu radios; GE cellular telephones; and other mobile communications products.
New products
Regency RSP500 VHF synthesized hand-held radio.
Circle 127

CommuniTech **Booth 809**
Existing products
Telephone headsets and accessories by ACS Communications, Plantronics, Unex and GN Netcom; power protection by PII/Datashield; telephone handsets by Walker.
New products
Anti-glare, anti-static CRT screens by Screen Data.
Circle 113

Computer Resources **Booth 131**
Existing products
Municipal equipment tracking system: Tracks maintenance costs for all communications systems, tracks technician productivity, maintains parts in-

ANI- Automatic Number Identification
The total solution



At last – for mobiles AND PORTABLES – a super reliable end-to-end ANI system.

This great system gets it all together with the S1515 ANI Encoder for portables, A1200 ANI Encoder for mobiles and the A1458 Identity display base unit. The A1458 queues up to 10 calls, has a time/date clock display and RS232 output for printer or computer display.

Sigtone ANI gives dramatic improvement in EFFICIENCY, SECURITY and CONTROL for all types and sizes of mobile radio fleets.

- Stop the nuisance callers
- Eliminate lengthy voice calling procedures
- Certain identification of channel users
- Emergency alarm improves driver safety
- Analyse channel utilisation with data logging

You'll get no FALSING and Sigtone's ANI is compatible with virtually all mobile and portable radios.

Sigtone ANI has it all together as an end-to-end package to give you all you could ask for in an ANI system.

For complete details of the total ANI solution, contact Sigtone today.

SIGTONE

Sigtone Inc.
Sunset/Vine Tower, Suite 1126
6290 Sunset Blvd.,
Los Angeles, CA 90028 8720
Telephone (213) 463 4474
FAX 910 321 2903
Fax (213) 463 4493

Sigtone, Inc. specialises in high quality, high performance, tone signalling products for radio communication.

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Circle (65) on Fast Fact Card

ventory and carries out interdepartmental billing.
Circle 180 See ad page 87

Console Systems **Booth 208**
Existing products
Centurion consoles; Minicomm desktop consoles; Microcomm consoles.
New products
Microcomm trunking control system.
Circle 122

CT Systems Booth 323
Existing products
Model 300 encoder-decoder; models 2100, 3000B, and 5100S communication service monitors; model 3000S communications service monitor with spectrum analyzer.
New products
Model 2300 communications service monitor with automatic and semi-automatic testing; model 2500 cellular tester, cell-site simulator and communications service monitor.
Circle 112 See ad page 39

Kantronics TM-1200™

REMOTE DATA AT A PRICE THAT'S IN REACH.

REMOTE SITES, RUGGED TERRAIN CHECK DATA FROM THE OFFICE OR CARPHONE

WITH COMPACT, ERROR-FREE PACKET DATA TECHNOLOGY

Remote data acquisition, SCADA, and polling were never so easy, versatile or accurate... With a Kantronics TM-1200™ Telemetry Modem, *you don't need a rack-mount to have high-performance.*

Size Advantage

A TM-1200 is only 2"x6"x9". But it performs in small places like large expensive systems. So you can make sophisticated remote data and electronic checks in places you couldn't until now.

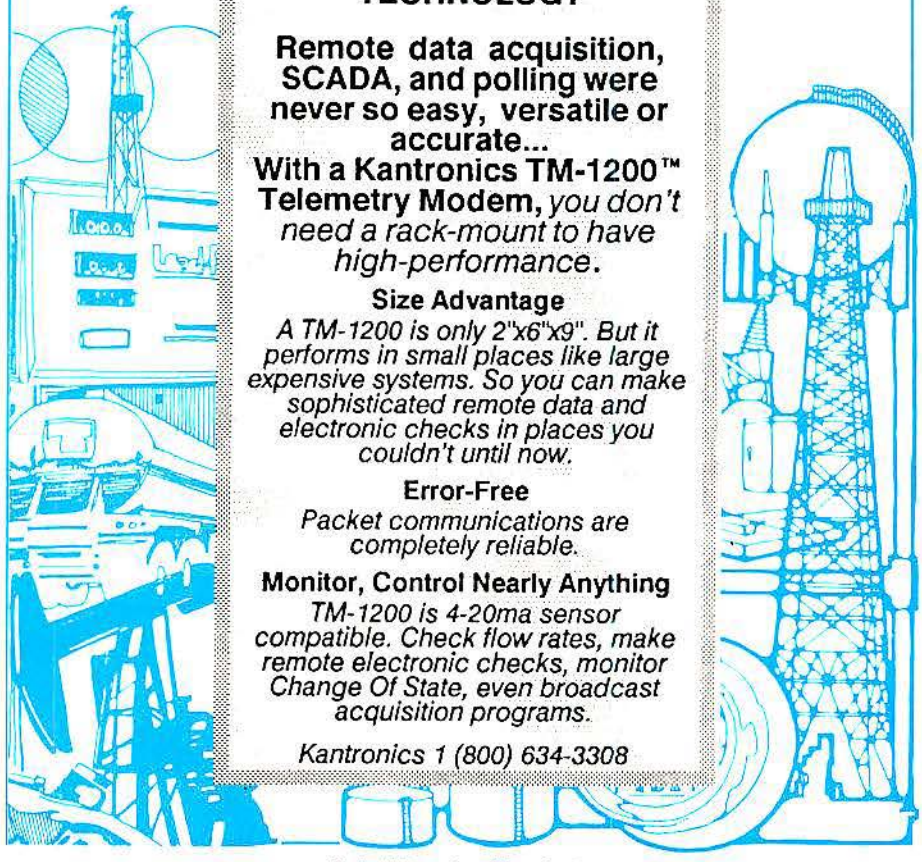
Error-Free

Packet communications are completely reliable.

Monitor, Control Nearly Anything

TM-1200 is 4-20ma sensor compatible. Check flow rates, make remote electronic checks, monitor Change Of State, even broadcast acquisition programs.

Kantronics 1 (800) 634-3308



Circle (66) on Fast Fact Card

Dataradio **Booth 145**
Existing products
S-1/S-5 asynchronous radio modems; SRM synchronous radio modems.
New products
MRM and turbo MRM mobile radio modems; VIS mobile data system; VIT vehicular dispatch terminal.
Circle 132

Decibel Products **Booths 516, 518**
Existing products
Combiner; duplexers; antennas.
New products
DB-1965 Cel-Tester; DB-737X elevated-feed antenna.
Circle 136

Dictaphone **Booths 508, 510**
Existing products
Veritrac 9000 multichannel communication recording and reproducing equipment; CallCheck 570 digital instant message repeaters.
Circle 181

Dinet Booth 427
Existing products
Unipage VI paging encoder; Data Mate mobile data terminal and controller; Vocalert voice alarm monitor.
New products
DVA-1000 digital voice announcer.
Circle 123 See ad page 85

Dynatech Tactical Communications Booth 436
Existing products
SK-3, SK-5, SK-7 security kits for portable radios; R-4 series wireless earphones; EM-1 series ear mics; TM-2 series throat mics; RHS series radio headsets.
New products
TM-2 voice-operated throat mic.
Circle 131 See ad page 22

E. F. Johnson **Booth 501**
Existing products
8600 series LTR trunking mobile products; 8500 and 8700 series LTR trunked portable; 7100 series Challenger mobile radios; 2400 and 5800 series Challenger portable radios; 3400 series data telemetry products.
Circle 174

ElectroCom Automation **Booth 208**
Existing products
MDT-870.
New products
Digicom System: D³; PDT-901.
Circle 173

Flash Technology **Booth 528**
Existing products
FTB-301 medium-intensity obstruction lighting for towers.
Circle 120

Gamber-Johnson Booth 319
Existing products
Single- and multiple-unit mounts for mobile radios, phones and data terminals; accessories for these products.
New products
StackMaster II heavy-duty multiple unit mounts with optional bases for different vehicle types.
Circle 153 See ad page 98

General Electric Mobile Communications Booth 500
Existing products
Voice Guard digital speech encryption system; C3 series command consoles; public-safety portable and mobile radios; weatherproof control units.
New products
16-Plus public-safety trunking system; compact portable series.
Circle 110 See ad page 37

GTE Cellular Communications Booth 326
Existing products
Solar-powered cellular call box system with computerized answering and maintenance center equipment and software.
Circle 116

GTE Government Information Services Booths 318, 320
Existing products
Posse-VT police records management; VT-Narco narcotics and organized crime analysis; Dispatch 3000 computer-aided dispatch.
Circle 146

Hadron Booth 218
Existing products
Mobile data telecommunications products including: MDT 400 message switch used for dispatch, status updates, general messaging and host computer inquiries. Includes generic CAD interface.
Circle 140

Harris Farinon Booth 419
Existing products
DVM6-45 with Digital VersaTility Insert (DVI) feature-enabling circuit board; Farscan remote surveillance and network management software system with Digital VersaTility Alarm problem-alerting feature; Urbanet 18Z.
New products
DVM18-8T with DVI.
Circle 108

HCS Telecommunications Booth 234
Existing products
Plantronics, ACS Communications and GN Netcom headsets for dispatch units; RadioMate headsets for portable and mobile two-way radios.
Circle 183 See ad page 76

Heischmann Booth 539
Existing products
Radio and telephone simulators for training.
New products
E-911 simulator for training.
Circle 126

Hughey & Phillips Booth 147
Existing products
Obstruction lighting; alarms; monitors; climbing devices.
New products
Ice protection devices.
Circle 142

ICOM America Booths 619, 621
Existing products
Land mobile communications equipment.
New products
IC-U18/H18 UHF and VHF portables.
Circle 155

IFR Systems Booth 314
Existing products
FM/AM-500A, FM/AM-1200S, FM/AM-1500 and A-8000 spectrum analyzer.
Circle 114 See ad page 27

Infocel Booth 821
Existing products

YOU'LL LOVE STI-CO® DISGUISED ANTENNAS

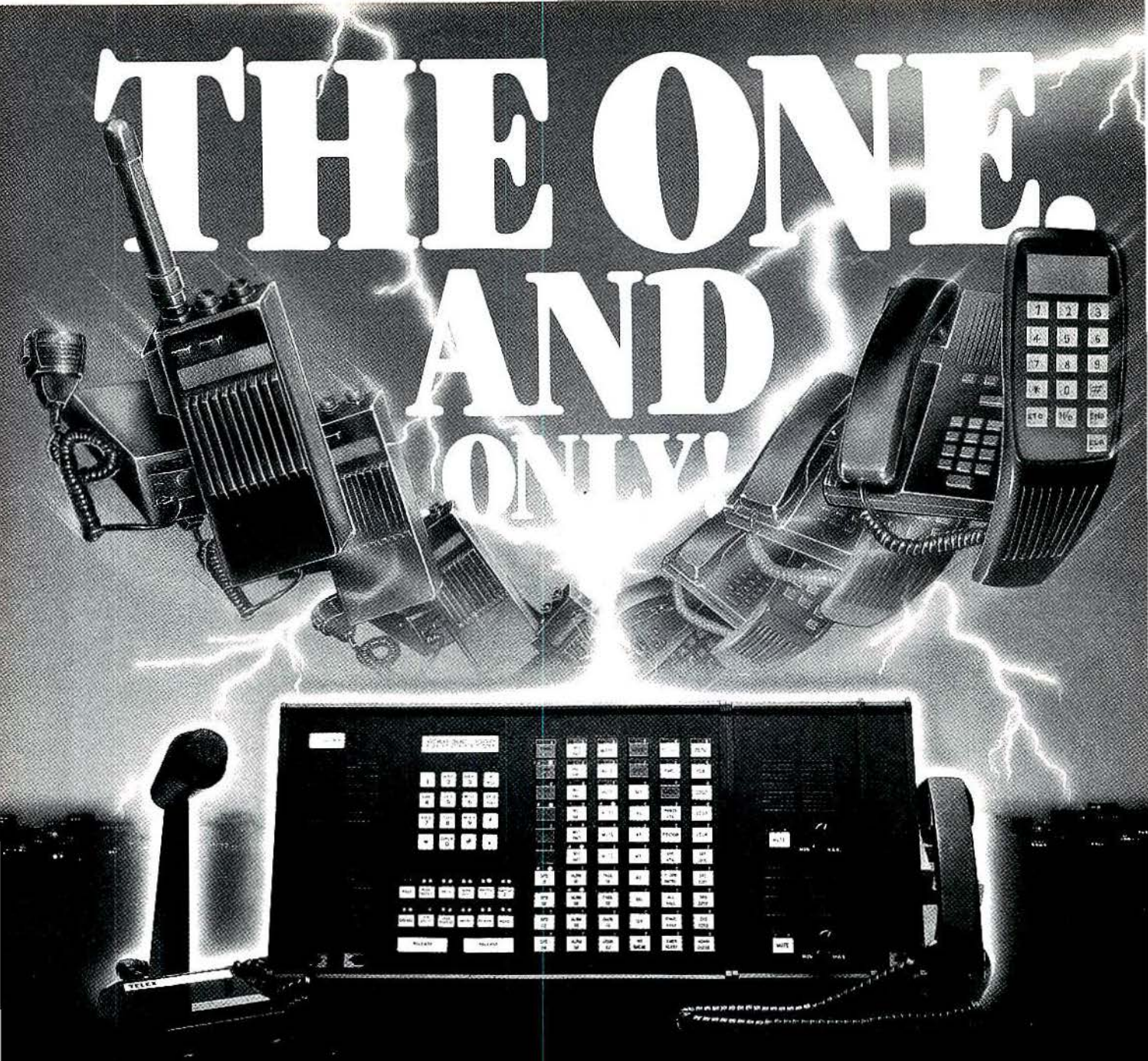
. . . IF YOU'RE CONCERNED ABOUT SAFETY, RELIABILITY AND PERFORMANCE.
STI-CO antennas are chosen by law enforcement agencies because of our total disguise, top quality workmanship, trustworthiness, and for the innovative technology that goes into *every* STI-CO product.

STI-CO. Where performance is the *only* measure of success.



STI-CO INDUSTRIES, INC.
36 LETCHWORTH STREET / BUFFALO, NEW YORK 14213 / (716) 881-3287

Circle (67) on Fast Fact Card



THE ONLY SYSTEM THAT FULLY INTEGRATES TELEPHONE AND RADIO IN ONE COMPACT CONSOLE!

POSITRON has the only system that combines radio and telephone into one compact and versatile unit! It also integrates paging and call identification like no other system does!

☐ Quicker, easier to use!
POSITRON re-defines "user friendly"! You enjoy faster access to features, because everything's at your finger-tips, in one easy-to-operate unit!

☐ More compact!
You get big-league performance with a small foot-print... everything you need, yet it takes up so little space.

☐ Highly versatile!
Completely software programmable, POSITRON lets you easily configure your system to your particular requirements such as: • Queue 1 to 4 • Instant transmit • Speed dial • Take over dispatcher • Ring select. It is compatible with your current equipment and easily expandable to meet all your needs.

☐ Highly reliable!
This POSITRON system was developed together with emergency services systems users thus ensuring the highest possible level of reliability.

☐ E 9-1-1
Suppliers of E 9-1-1 Emergency systems and products.

For further information, write or call:

POSITRON

Where Communication Technologies Meet

Positron Industries Inc.
5101 Buchan Street
Montreal, Quebec, Canada H4P 2R9
(514) 345-2200

Head Office: Montreal Offices: New York, Chicago, Los Angeles, Toronto

Circle (68) on Fast Fact Card

CADPlus computer-aided dispatch system; E-911 interface module, MDT interface module; RecordsPlus police records management system.
Circle 102

International Crystal Manufacturing (ICM) — **Booths 329, 331**
Existing products
Crystals and channel elements; ICM pagers.
Circle 118 — See ad page 50

ISC Cardion Electronics — **Booth 413**
Existing products
8000 series microwave radio; 9000 series microwave radio; 9500 series DTL multiplex.
Circle 178 — See ad page 82

Kustom Electronics — **Booths 512, 514**
Existing products
DXT mobile digital terminal; MCT-30 mobile digital terminal; KST mobile status terminal; Kommunicator desktop communications console.
New products
CCG DXT mobile digital terminal with Chinese and English language capability. Terminal is capable of generating, displaying, transmitting and receiving more than 13,500 common Chinese characters. Data rate exceeds 4,800bps. The CRT display has 12 lines of 16 characters per line plus two status lines.
Circle 129

Larsen Electronics — **Booth 321**
Existing products
Mobile, portable and base antennas from 27MHz to 1.2GHz.
New products
KG-825; NMO-MM; KG-UHF.
Circle 152 — See ad pages 62-63

Lightning Eliminators & Consultants — **Booth 810**
Existing products
Lightning protection and prevention systems.
New products
Spine ball ionizer; guy choke; surge eliminator.
Circle 166

Magnavox/Nav-Com — **Booths 818, 820**
Existing products
MX2400T transportable satellite communication terminal; automatic vehicle location system.
New products
MX5400 GPS satellite navigation system; dead-reckoning system for GPS navigators.
Circle 158

MaSys — **Booth 312**
Existing products
ENFORS public-safety computer systems for CAD, records, MDTs and other public-safety information system functions.
New products
CAD enhancements; full multi-agency, multi-responder systems for E-911 environments.
Circle 135

Maxon Electronics — **Booths 601, 603**
Existing products
Land mobile FM two-way radio equipment including VHF and UHF mobiles, portables; intrinsically safe portables and accessories; telemetry and data products.
Circle 130 — See ad page 47

METS — **Booths 226, 228**
Existing products
Fleet management systems including: automatic vehicle location; mobile data terminals; dispatch, routing and scheduling software; mapping and geographic information systems.
New products
Stolen vehicle recovery network (SVRN).
Circle 164

Microwave Networks — **Booth 107**
Existing products

ATTENTION GETTER



DIAL ACCESS PAGING TERMINALS FOR:
FACTORIES, HOSPITALS AND SMALL RCC's / PCP's

	CAPACITY	FORMATS	TELCOs	TX ZONES	TALKBACK	FIELD PROGRAMMABLE	UNATTENDED AUTO PAGE	VOICE PROMPTS	GROUP PAGING
DAPT JUNIOR	100 - 1000	5	1	1	DUPLEX	YES	YES	—	SOME FORMATS
DAPT PLUS	200 - 1000	9+ CUSTOM	3	4	DUPLEX OR SIMPLEX	YES	YES	8	ALL FORMATS

First in Features-Quality-Performance-Value

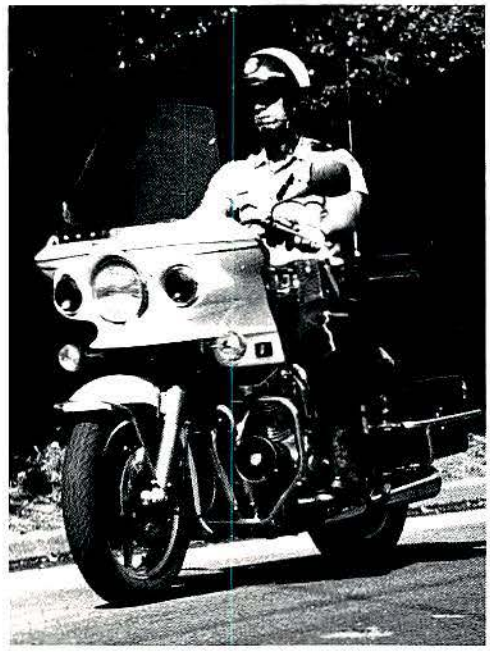
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2930 Richards Rd. S.E.,
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Telex: 5106010251 ZTRON SEA UQ
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ZETRON

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from city cruising to highway pursuit!



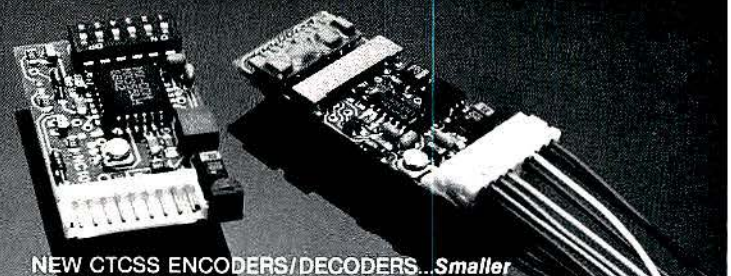
Used with portable or motorcycle radios, Setcom's helmet communication system with handlebar switching eliminates risky fumbling with hand microphones and loss of messages due to engine, wind or siren noise.

Proven in daily, worldwide use by police departments and highway patrols, our equipment provides immediate improvement in safety and efficiency. For more information, contact:

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NEW CTCSS ENCODERS/DECODERS...***Smaller size, easier installation plus competitive pricing!*** Now even better than before...no more wires falling off PCB's as they are now installed in a sub-miniature connector that simply plugs into a header on the PCB. Both models offer high stability, immunity to RF, high pass filter and meet all specs for EIA RS-200-A.

Model NC102 — Size: 0.8"W x 1.60"L x 0.20"H
Model NC106 — Size: 1.0"W x 1.7"L x 0.22"H

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Circle (71) on Fast Fact Card

APCO

18GHz DS3 video radio; 23GHz DS3 and 4DS1 video, data radio; both portable radios work with any interface.

New products

23GHz Ethernet interface with optional encryption; 23GHz Tokin ring interface.

Circle 182

Midland Land Mobile Radio — Booth 240

Existing products

Crystal-controlled and synthesized portables, mobiles and base stations; repeaters in all conventional bands; 800MHz trunking systems and accessory equipment.

New products

Syn-Tech II mobile vehicular repeater (model 70-2953/2954); marine and/or land mobile Syn-Tech one-piece and remote mount (70-343/443); 2W-5W four channel crystal-controlled portables (model 70-040/064/144/244); 30W UHF Syn-Tech II mobile (model 70-5300B).

Circle 157 See ad page 25

Mobile Radio Technology — Publications bin

Existing products

Written to keep industry professionals up to date on the latest in equipment, technology, techniques, business developments, legal and regulatory matters, ***MRT*** is recognized as the leading source of technology-oriented industry guidance.

Circle 177

Modular Communications Systems — Booth 335

Existing products

Ultra-Page 96 multiformat paging encoder includes all 1 + 1, 2 + 2, DTMF, 5/6, rotary and custom call formats; transmitter steering to 16 channels; user-programmable.

New products

The Ultra-Com 96 user-programmable communications console is available in three configurations: switch group version, LCD integrated version and CRT version. Includes management statistics and personnel and vehicle status.

Circle 161

Multiplier Industries — Booth 710

Existing products

Direct replacement batteries for Motorola, GE, ICOM and Yaesu two-way radios, pagers and communications systems.

New products

20 direct replacement batteries for Motorola's HT-50, HT-600, MT100/MTX-800; STX; and Radius P-10/50, P-100 and P-200.

Circle 103

MX-COM — Booths 322, 324

Existing products

MX P39 computer card radiopaging terminal; PVT Squelch tone-controlled channel access; VSB rolling code speech encryption system; Radio MailVox voice store and forward mobile option.

New products

MX P1381 Radio MailVox voice storage card. The

card allows a two-way mobile to act as a repeater station for a hand-held unit to increase talk-back range.
Circle 154 See ad page 9

Orbacom Systems **Booth 541**
Existing products
The TDM-150 distributed microprocessor consoles; Calida desktop 16-channel user-programmable console.
Circle 144 See ad page 68

Phoenix Audio Communications **Booths 905, 907**
Existing products
Genesis logging system: audio tape (3600' × ¼", ½", 1") with serial ID, plastic strap with hanging hook and log book; Model 1846 bookcase-style P/N 1646 cabinet-top wall-mount storage unit.
New products
Model 3783 × 2 open library—multi-unit; model 7314 library unit in English walnut; model 7316 library unit with doors.
Circle 165

PolyPhaser **Booths 115, 117**
Existing products
More than 450 models of patented lightning and EMP coaxial protectors for dc to 6GHz; telephone, dc remote, T-1 LAN protectors for twisted pair; ac protectors for 120V, 240V, 480V; 1 and 3 phase; and 12Vdc, 24Vdc and 48Vdc; protectors for 30A and 50A.
Circle 139 See ad page 28

Positron Industries **Booths 222, 224**
Existing products
Integrated, software-controlled E-911 combines an ANI/ALI controller with multiplexer and integrated ANI/ALI information display into one intelligent display module. One complementing TRCC dispatch console integrates telephone and radio capabilities to offer maximum flexibility, and a capacity of 240 lines.
New products
Answering Position and ICM.
Circle 115 See ad page 72

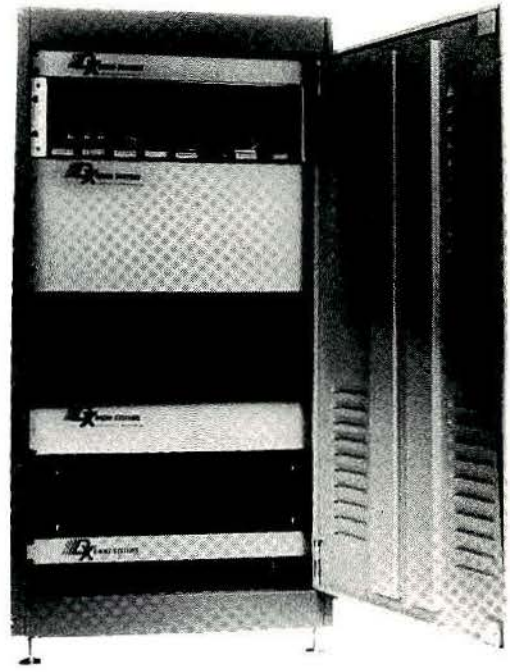
PSW3 **Booths 325, 327**
Existing products
Computer-aided dispatch; records management systems; message switching systems.
New products
Microcomputer CAD activity reporting patrol scheduling systems.
Circle 128

Quintron **Booth 303**
Existing products
Base stations and control equipment for two-way mobile communications.
New products
Simulcomm control system for automatic monitoring and alarm notification with simulcast communication systems.
Circle 121 See ad page 45

Radio Systems **Booth 337**
Existing products
Model PR1605 and model PR1405 synthesized submersible 80-channel hand-held transceivers; transportable weatherproof repeater systems; VOX-actuated accessories; telemetry data transceivers. Products cover 30MHz to 50MHz, 138MHz to 174MHz and 405MHz to 512MHz.
New products
Model PR1605 and model PR1405 synthesized submersible 5W, 80-channel hand-held transceivers. Features include dual priority scanning and EEPROM memory. Programming may be "cloned" from one unit to another. Both models are available to cover 30MHz to 50MHz and 138MHz to 174MHz.
Circle 172

RAM Communications Consultants **Booth 822**
Existing services
Communications consulting services.
Circle 101

*Mod-u-lárity



DX Radio systems brings FLEXIBILITY with MODULARITY for our complete line of **Base Station/ Repeaters either in portable or fixed station configurations.**

With **Modularity** we can make your complex systems simple.

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Circle (72) on Fast Fact Card

Rohn **Booth 340**
Existing products
Laminated fiberglass equipment shelters; guyed communications towers; self-supporting communications towers.
Circle 169

Ross Associates **Booth 1012**
Existing products
Surveillance equipment; electronic mail and message system.
New products
Electronic mail and message system; "Cassie" SX-4 manufactured by Ross Distributing.
Circle 143 See ad page 16

Schlumberger Instruments **Booth 128**
Existing products
Radio test sets models 4031 and 4040.
Circle 119 See ad page 29

Setcom **Booth 118**
Existing products
Motorcycle helmet ComKits; SCBA ComKits and headsets for use with portable and mobile radios; voice-operated switches (VOX).
Circle 145 See ad page 74

SFA **Booth 712**
Existing services
Communications consulting for public-safety applications: trunking systems, microwave, telephone, E-911, conventional radio, AVL, MDT, and CAD; system design, bid specifications, procurement and installation support.
Circle 151

WACOM

LOW LOSS TRANSMITTER COMBINERS
RECEIVER MULTICOUPLERS
150-450-800 MHz

DUPLEXERS and CAVITY FILTERS, including our patented B_p B, CIRCUIT ® FILTERS, for all bands within the frequency range of 30 to 960 MHz. Investigate this complete line of high performance products.

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WACO, TEXAS 76702 • 817/848-4435

Circle (73) on Fast Fact Card

Shure Brothers **Booths 902, 904**
Existing products
Hand-held and base station mics for land mobile applications, featuring ModuLink quick disconnect cordset system.
New products
SmartAmp mobile RF amplifiers, featuring intelligent protection circuitry. Series includes eight models: RF-V1, RF-V2, RF-V3, RF-V4, RF-U1, RF-U2, RF-U3, RF-U4.
Circle 117 See ads page 89

Sinclair Radio Laboratories/ Sinclabs **Booth 709**
Existing products
Mobile, portable and base station antennas, duplexers, filters, combiners, multicouplers and accessories.
Circle 105 See ads pages 79, 81

Standard Communications **Booth 1013**
Existing products
Two-way communications equipment including: GX3000 series of conventional and trunked mobile radios; HX320 series hand-helds; HX400T series trunked hand-helds; EX10 series mobile range extender; RP70 series desktop repeaters; 934 series lowband hand-helds; 966 series lowband mobiles.
New products
HX340 series hand-helds; HX530 series hand-helds; HX410 series hand-helds.
Circle 156

Starkey Labs **Booth 909**
Existing products
Custom-fit headsets for emergency communications applications featuring 4-wire and 6-wire push-to-talk; a newer model headset will feature a noise suppression circuit.
New products
EIIP compatible with all major manufacturers of dispatch consoles.
Circle 175

Tait Electronics **Booths 233, 235**
Existing products
Repeaters; base stations; portables; VHF, UHF aviation mobiles.
New products
T800 series base station modules.
Circle 133

RadioMate

Headsets for Portable Radios



• Lightweight and Muff
• Push-to-Talk and VOX

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hcs Telecommunications
Specializing in HEADSETS

Visit us at APCO Booth #532.
Circle (74) on Fast Fact Card

Tandem Computers **Booth 533**

Existing products

Tandem Computers will feature two companies in its booth: Eyring, demonstrating its message switch system; and Systems Concepts, showing its computer-aided dispatch system and its jail management system. All three applications will run on a Tandem CLX.

Circle 111

Teletec **Booth 146**

Existing products

IQ1000 computerized control head with fiber optic control cable link to Omni transceivers in VHF highband and UHF.

New products

Light bar and siren control option; IQ2000 multiband control head; the Iowa Highway Patrol special products crossband vehicular repeater system.

Circle 179 See ad page 49

TPL Communications **Booth 302**

Existing products

35MHz to 960MHz mobile, base and repeater RF power amplifiers; dc power supplies; and mobile adapters.

New products

Paging amplifiers: 300W VHF lowband, 200W UHF, and 150W at 800MHz.

Circle 107 See ad page 68

TX RX Systems **Booths 429, 431**

Existing products

Duplexers; filters; multicouplers; repeater amplifier systems; RF system products.

Circle 141

Uniden **Booths 109, 111**

Existing products

900MHz trunking; 800MHz trunking and conventional; two-way radio products for VHF and UHF lowband.

New products

F-200KT UHF 25W mobile; F-300KT VHF 30W mobile; F-52DT VHF 5W portable; F-42KT UHF 4W portable.

Circle 149 See ad page 55

Unisys **Booths 1001, 1003**

Existing products

APLIMS advanced public-safety information management systems; A-series computers, LINC-4GL; STOPS standardized tactical on-line public-safety systems; U-series Unix computers, Mapper-4GL.

New products

APLIMS 2.0; Micro A.

Circle 138

U. S. CommLink **Booth 911**

Existing products

Cellular and RF call boxes.

New products

The "Master/Slave" call box system using either cellular, trunking or two-way master controller.

Circle 159

U. S. Telecom International **Booth 108**

Existing products

The PhoneMaster II PNS call down system; MVA notification call down system with dial and deliver, bulletin board, Super Answering, and Hazmat notification and information capabilities.

New products

The Notifier multiline call down system with Auto Guide Book; Hazmat auto version allows a caller to simply enter the "DOT" ID from any Touch-Tone phone to hear the correct response to a hazardous materials incident (voice version of "DOT P 5800.4—Guidebook").

Circle 160

U S West Enterprises, Emergency Systems Division **Booth 537**

Existing products

Positron SDTs and controllers. Plant equipment telephone systems: ComCentrex, AT&T and a software system for the AMI-mation and ALI-mation call record management system.

New products

EmergiTech enhanced 9-1-1 system (CAD optional); Vital Information personal computer-based systems used to build a database for use with 9-1-1; Proctor ANI display call loggers; Magnasync voice recorders and voice loggers.

Circle 167

Valmont Industries **Booth 129**

Existing products

Tapered tubular steel poles as tall as 250 feet; free-standing lattice towers to 400 feet; and guyed lattice towers to 1,000 feet. Engineering support, leasing and installation services; and ancillary equipment.

Circle 134

Vega Signaling **Booth 614**

Existing products

The 500 series tone-remote and dc-remote consoles including the C-514B four-frequency remote and the C-516 six-line remote; the 200 series tone and dc remote station adapters; DTMF encoders and decoders; two-tone sequential mobile decoder; system modules.

New products

C-511 two-frequency desktop tone-remote control console with desk microphone; C-512 two-frequency wall-mount tone-remote control console with handset and cup; C-532 two-frequency desktop dc remote control console with desk microphone; C-533 two-frequency wall-mount dc remote control console with handset and cup.

Circle 104 See ad page 1

Vision Technologies **Booths 318, 320**

Existing products

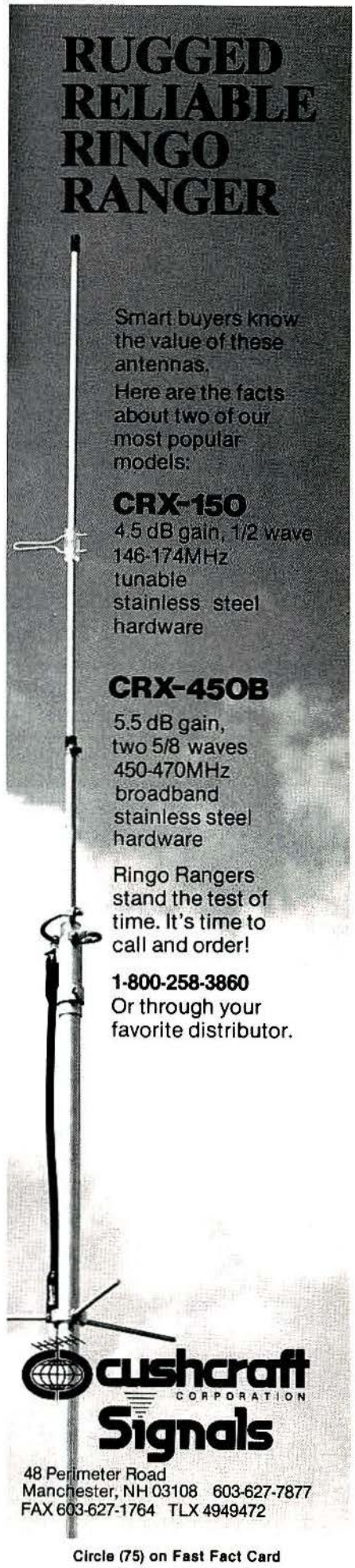
Posse-VT police records management; VT-Narco narcotics and organized crime analysis; Dispatch 3000 computer-aided dispatch.

Circle 147

Whelen Engineering **Booth 631**

Existing products

Base station and remote station products for control and status monitoring of Whelen high-power



Circle (75) on Fast Fact Card

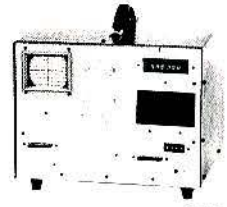
voice and siren systems; mechanical siren systems.
New products
Base station digital voice record and playback system; weather data telemetry system; BC-864 multiple-input base controller, contention management system.
Circle 100

Zetron — Booths 706, 708
Existing products
Series 4000 dispatch consoles; model 21 instant recall recorders; model 25 programmable encoders; model 10 and model 15 multiformat encoders.
New products
Model 921 ALI instant recall recorder; Model ZM-A DTMF microphone; Model 24 instant call encoder.
Circle 150 — See ads pages 23, 73

Be sure to pick up a copy of *MRT* in the publication bins at APCO.

SERVICE MONITOR
MEASUREMENTS MODEL FM 110

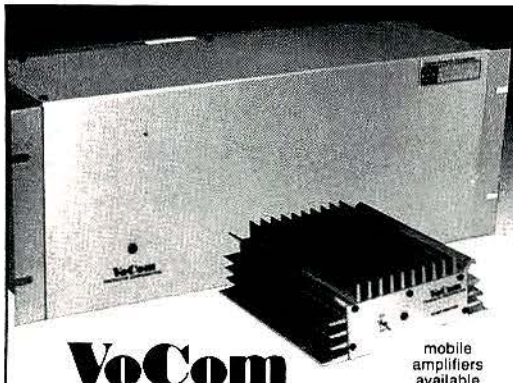
- Covers all business channels from 30MHz to 512MHz
- Monitor: 2uV, frequency error display, scope deviation display
- Generator: Calibrated output up to 10mV, Sinad display
- Built-in Tone Generator



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RACK MOUNTED REPEATER AMPLIFIERS
VHF-UHF-800 MHz

- Continuous duty for repeater/paging applications
- 25, 50, 100 or 200 watt output
- Available with drives from 200 mW to 50 watts
- Primary power 13.8V dc or optionally 90–130V ac, 60 Hz
- Aligned and tested on your frequencies for maximum output and efficiency

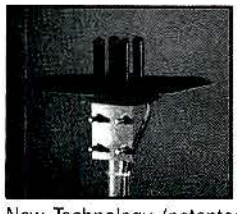
mobile amplifiers available

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108-1000 MHZ RADIO DIRECTION FINDING



★ Interference Location
★ Stuck Microphones
★ Cable TV Leaks
★ ELT Search & Rescue



New Technology (patented) converts any VHF or UHF FM receiver into a sensitive Doppler shift radio direction finder. Simply plug into receiver's antenna and external speaker jacks. Models available with computer interface, synthesized speech, fixed site or mobile - 108 MHz to 1 GHz. Call or write for details.

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Circle (78) on Fast Fact Card

Late entries

Antenna Specialists — Booths 504, 506
Existing products
Land mobile antennas for lowband, highband, UHF, trunking and cellular applications; base and portable antennas; Andrew coaxial cable. Site management products; combiners; duplexers; multicouplers; filters. Cell-U-Phone and power amplifier; cellular boosters.
New products
ASDP917 series adjustable angle-elevated feed cellular antenna; portable antennas for lowband, highband, cellular and trunking; ACD2600 series UHF duplexer with a bandpass and band-reject filter; ASP-2600 series steerable dipole gain antenna.
Circle 186 — See ad page IFC

Integrated Computer Concepts — **Booth 903**
Existing products
An integrated computer-driven dispatch and management system that supports mobile data terminals and automatic vehicle tracking. The system works with computers used by state, county and municipal agencies. Features include an inventory and evidence control application; and a system that permits mapping the dynamics of specific information.
Circle 187

Motorola, Communications Sector — **Booth 600**
Existing products
SmartNet Systems II; Spectra mobile radio; MTX-900 series portable radio; Centracom Series II Plus CRT.
New products
Stat-Alert status and message system; Keynote tone and voice pager.
Circle 185

Shinwa Communications of America — Booth 132, 134
Existing products
Two-way hand-held models SH401P, SH502P, SH505KG, SH404GX, SH505G, SH405G, SH505GII, SH405GII; two-way mobile models SC440X, SC550X; pager models SR58VT, SR48VT, SR36VT, SR56VT, SR46VT, SR32VT, SR52VT, SR42VT.
New products
Two-way hand-held model SH505GX; two-way mobile model SC350X; pager model SR49DVT.
Circle 184 — See ad page 48

Sti-Co Industries — Booths 607, 609
Existing products
Disguised mobile two-way antennas and accessories; cellular look-alike VHF antennas; transit antennas.
New products
Model TRL-BL-450 cellular look-alike UHF antenna.
Circle 188 — See ad page 71

Midland obtains contract from Forest Service

Midland LMR, Kansas City, MO, has garnered a U.S. Forest Service contract valued at approximately $700,000 for the purchase of land mobile equipment. The contract includes Syn-Tech 80-channel programmable dash- and trunk-mount mobiles; Syn-Tech II dash- and trunk-mount mobiles with 320 channels; 80-channel desktop base station; and Base-Tech continuous-duty repeaters and base stations. Options are available under the contract.

Any Forest Service procurement office may purchase orders against the contract. Department of Agriculture agencies and state forestry organizations may purchase equipment under the contract with U.S. Forest Service approval.

Regency to change name to Relm Communications

Regency Electronics, Indianapolis, will use the name Relm Communications, effective Sept. 5. With the name change comes a new logo. The name change follows the sale of Regency's consumer products division.

"We are not the consumer products company that Regency is closely identified with, and electronics is too broad for our specific focus," said Steven Wilkening, Regency president.

Relm will focus on two product lines: land mobile and utility load management. Land mobile products the company carries include two-way portables, mobiles and base FM radios; repeaters; and optional accessories. Administration, engineering research and development, purchasing, and sales and marketing will be conducted in Indianapolis. Manufacturing and customer service will continue to be provided at the company's West Melbourne, FL, manufacturing facility.

Multiplier names 4 distributors

Multiplier, Mount Kisco, NY, has appointed four new distributors. They include: Pulstar Distributing, Professional Communications Products Division, 285 N. Snelling Ave., St. Paul, MN 55104; Walters Industrial Electronics, 3635 Main St., Kansas City, MO 64111-1964; Western Radio Electronics, 4797 Ruffner St., San Diego, CA 92111; and Lynntronics, Division of Specific Energy, 6205 N. 27th Ave., Phoenix, AZ 85017.

John R. Neubauer, P.E.

Communications consultant John R. Neubauer, P.E., died April 5 after a lengthy illness. He was 74.

Neubauer retired from RCA as an engineer in 1972. He then became a transportation, security and mobile radio consultant. Neubauer had served as a member of *MRT's* editorial advisory board.



Circle (79) on Fast Fact Card



Let Sinclair set you straight.

Design engineering and quality equipment makes the difference between profit and loss.

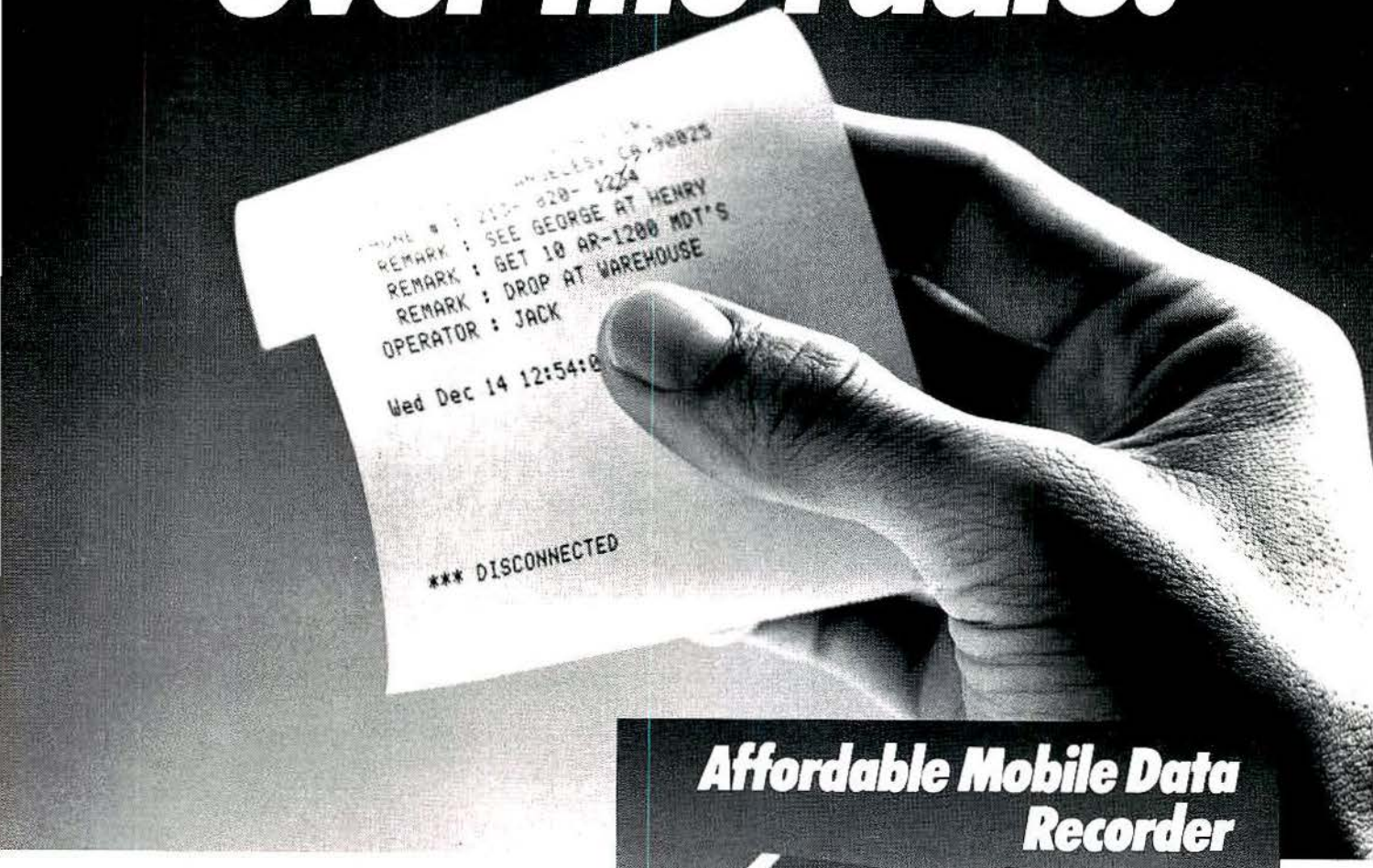
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Circle (80) on Fast Fact Card

Get it in writing over the radio.



Affordable Mobile Data Recorder





Affordable is the key word... Henry proudly offers this ultra-small, mobile-mount, data recorder for under $600.00!

The AR 1200 digital data receiver instantly receives, stores and/or prints messages typed into a personal computer and sent from the base station radio. In addition, you can add a lap-top computer to the mobile unit and create a two-way data system (base to mobile to base).

Messages can be addressed to a specific mobile unit and privacy is afforded by message encryption capabilities.

Printer accommodates 40 characters per line. The unit is easy to use, and no training is necessary.

The AR 1200 is compact, easily installed and very affordable. Case measures 8¼" x 4⅝" x 2⅛".

Phone TOLL-FREE for complete information.

Over a half-century of reliability in communications.

HENRY RADIO

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Circle (81) on Fast Fact Card

AmeriCom, Johnson sign distribution pact

AmeriCom, Atlanta, and E. F. Johnson, Waseca, MN, are set to distribute AmeriCom's mobile radio switch products. AmeriCom and E. F. Johnson are to be exclusive distributors of the AmeriCom switch technology for the specialized mobile radio (SMR) market in the United States.

Included in the distribution plan is BCE Mobile Communications, a Montreal company of Bell Canada Enterprises, and Lenbrook, Toronto, the co-owner with Johnson of E. F. Johnson Canada. Johnson, BCE Mobile and Lenbrook are to invest in AmeriCom. BCE Mobile and E. F. Johnson Canada are expected to have exclusive distribution with AmeriCom in Canada.

GE Canada to distribute Coded mobile data products

GE Canada Mobile Communications will distribute Coded Communications products. CCC Coded Communications, Carlsbad, CA, anticipates shipments to Canada of $8 million to $10 million during the next three years. Coded makes mobile data communications products; GE Canada carries two-way radio and cellular communications products.

Kustom lands MDT contract with Alabama highway patrol

Kustom Electronics, Lenexa, KS, will install a mobile data communications system in highway patrol vehicles for use throughout Alabama. The system consists of a computer-aided dispatch system furnished by Unisys, 25 General Electric base stations and 25 Kustom 4,800 baud mobile data terminals. The system will be expanded to 60 base stations and more than 600 DXT MDTs.

Hark offers 2-year warranty

Hark Systems, North Charleston, SC, offers a two-year warranty program as a standard feature for its product line. The program became effective in September.

SIRSA relocates, implements frequency selection program

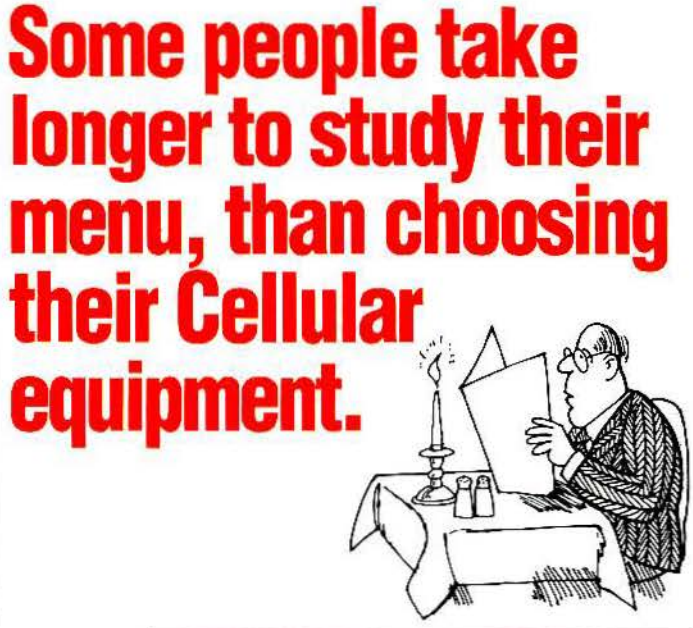
The Special Industrial Radio Service Association (SIRSA) has moved its offices to 1110 N. Glebe Road, Suite 500, Arlington, VA 22201-4714. The association's phone and fax numbers remain the same.

IFR names distributor

IFR Systems, Wichita, KS, has named Talley Electronics, Sante Fe Springs, CA, as its west coast distributor of IFR service monitors and spectrum analyzers. Talley will cover Arizona, California, Hawaii and Nevada.



Circle (82) on Fast Fact Card



Circle (83) on Fast Fact Card

Lindgren moves to larger plant



Lindgren RF Enclosures, Glendale Heights, IL, has added 28,000 square feet to its operations with the move to a new building that houses offices, a research and development department, and production facilities.

Shafer & Associates moves

Shafer & Associates and Shafer Tower Services have moved to Suite 1700, 3050 Post Oak Boulevard, Houston, TX 77056. The company may be called at 713-621-4499.

Glenayre acquires voice and data firm

Glenayre Electronics, Vancouver, British Columbia, has added to its radio communications holdings with the purchase of RMS Industrial Controls, Coquitlam, British Columbia. RMS manufactures voice and data radio communications products for bus transit, light rapid transit and rail markets.

Ora forms European subsidiary

Ora Electronics, Chatsworth, CA, has established a European subsidiary based in Aylesbury, Bucks, near London. Ora Electronics (UK) includes sales offices and warehouse and shipping facilities. Ora has developed an antenna line specifically for the European markets. The subsidiary carries antennas, phone mounts, interconnect cable assemblies, connectors and installation products.

Cue Paging establishes independent sales reps

Cue Paging, Irvine, CA, has developed a network of independent sales representatives called "GAMRs," which stands for general area marketing representatives. The GAMRs are expected to help the company to expand its paging network in areas where it lacks an affiliate and distributor representation.

Terminal software supports Shinwa DVT pager

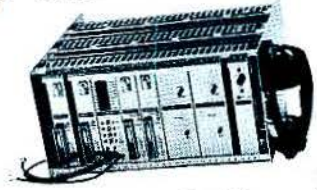
Commonwealth Communications Industries, Ashland, VA, offers a software upgrade for its Mark digital paging terminal that supports the Shinwa DVT pager. The pager provides voice in addition to its RPC1 (formerly POCSAG) numeric display paging format. The software upgrade for the paging terminal includes system memory and channel cards.

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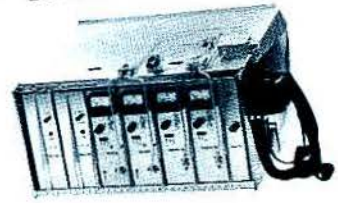
- Compact Modular Design
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- 9.6/14.4 KB Data Capability
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Circle (52) on Fast Fact Card

Association of Communications Technicians launches membership drive

Members of the Association of Communications Technicians (ACT) leadership council have launched a bold membership drive: According to the council's goal, ACT will boast a membership increase of 500 by March 1990.

Council members who attended the March 1989 meeting initiated the drive, subject to ratification by a quorum. Council members at the meeting included chairman Ian Wright of Dominion Communications Systems, Chester, VA; Alan Haley of Master Electronic Systems Associates, Tacoma, WA; and Joseph Gately of Gately Communication, Hampton, VA.

ACT, a membership section of the National Association of Business and Educational Radio, grew by 454 members during the previous year. The technician organization's membership numbers in excess of 2,000.

In the current membership drive, the association and its support staff expect to pass the word about ACT via trade schools, industry magazines and selected lists of radio licensees. Reaching the right instructor at trade schools has been a problem for ACT. ACT members are encouraged to send to the association office the names of instructors who teach radio communications subjects at their local trade schools.

For information about the association, call NABER at 800-759-0300. Ask for "technician services."

Please send information about ACT

Name _____

Address _____

_____

_____

MAIL TO: Technician services, NABER, 1501 Duke St., Alexandria, VA 22314.

Do you want to know more about ACT, or do you know someone who ought to receive information? Fill out this coupon, clip it and mail it to NABER for a packet of information about the only industry association for communications technicians!

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800 to 980 MHz

High performance, low cost directionals for RURAL FIXED SUBSCRIBER and general BASE STATION applications.

- **Three models in each of two 100MHz bandwidths easily cover US and European bands.**
- **Standard units with 9.3 and 6.5dBd gain provide a choice for fixed rural situations.**
- **Heavy duty 9.3dBd versions for any base station or subscriber need.**
- **Rugged, radome enclosed design gives extra long service life.**
- **Extremely high back energy rejection for enhanced performance by themselves or in arrays.**
- **Significantly lower cost for equivalent performance makes them the value choice over other panels currently on the market.**

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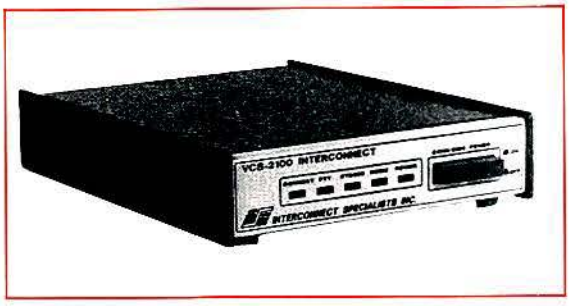
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Circle (95) on Fast Fact Card

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SIMPLEX PATCH AVAILABLE



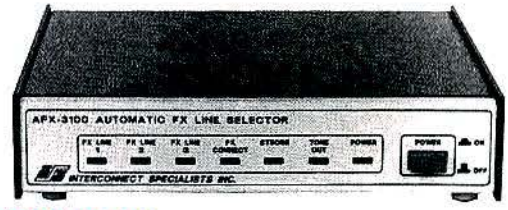
VCS-2100 VOX CONTROLLED SAMPLING INTERCONNECT

The Interconnect Specialists Inc. (ISI), VCS-2100, uses a combination of VOX control from telephone line audio, and sampling of receiver noise, to achieve the optimum control method for a simplex interconnect. No sampling interruptions occur during normal conversation. Turn-a-round beeps make operation very smooth and easy.

The VCS-2100 features the ISI exclusive, Automatic Setup. This feature eliminates the trial and error method of sample window setup. Our Quick Start Set-up procedure gets the VCS-2100 up and running, without complicated programming. The VCS-2100 is superior to any other interconnect in its price range. It is a plug-in replacement for the popular 510SA Smart Patch.

FEATURES:

- **AUTOMATIC SET-UP**
  Automatically sets the sample window for your transceiver. No more trial and error.
- **TURN-A-ROUND BEEPS**
  Sends beep to telephone line, and to mobile indicating it's their turn to talk.
- **USER PROGRAMMABLE CW ID**
  CW ID can be programmed using DTMF. ID can be programmed to be sent at the beginning, the end, both, or not at all.
- **AUTOMATIC BUSY DISCONNECT**
  Automatically disconnects if the telephone number dialed is busy.
- **HOOK-FLASH**
  Used to make a second call without disconnecting and re-connecting. Also can be used for phone company services which use Hook-flash.
- **CALL WAITING**
  If a mobile call is attempted and the line is in use, a beep is sent to the phone line indicating that the mobile wants to make a call. Then when the line becomes available, a ring-out is transmitted to the mobile.
- **RING-OUT (REVERSE PATCH)**
  Can be programmed to ring-out one time, on each ring, or not at all, when the line rings.
- **SINGLE OR MULTI DIGIT CODES**
  Connect or disconnect codes can be single * and #, or * and # plus two digits.
- **CALL LIMIT TIMER**
  Can be set for 3, 4, or 5 minutes, or disabled. Can be programmed to reset with *.
- **MOBILE ACTIVITY TIMER**
  Causes disconnect if mobile drives out of range. Can be set to 30, 45, 60, or 90 seconds.
- **TOLL RESTRICT**
  The first digit dialed cannot be a "1" or a "0". Rearms after dialing is complete.
- **PHONE LINE IN USE INHIBIT**
  Prevents interrupting a call when the patch shares the telephone line with a telephone.
- **TOLL RESTRICT DEFEAT CODE**
  A special programmable code allows toll calls. Also allows access to line, even if line is in use.
- **TONE OR PULSE DIALING**
  Switch programmable for Tone or Pulse dialing. Pulse dialing can be used on a tone line.
- **HALF DUPLEX MODE**
  The VCS-2100 can be used as a repeater interconnect in this mode.



AFX-3100 AUTOMATIC FX TELEPHONE LINE SELECTOR

The AFX-3100 automatically routes mobile telephone calls to one of four trunk lines, as determined by the first three digits (exchange code) of the telephone number dialed. One local line and three FX lines can be accommodated. Up to 640 exchanges can be assigned to any of the three FX lines. A built-in keyboard is provided for programming of FX exchange numbers. Local line exchanges need not be programmed.

- **HANDLES BOTH INCOMING AND OUTGOING CALLS**
- **COMPLETELY TRANSPARENT TO THE MOBILE USER**
- **NON-VOLATILE MEMORY REQUIRES NO BATTERY BACK-UP**
- **RS 232 SERIAL PORT FOR PROGRAM VERIFICATION**

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Circle (64) on Fast Fact Card

Amateur association opposes United Parcel rule petition

The American Radio Relay League (ARRL), Newington, CT, has filed comments opposing a petition for rulemaking filed with the FCC by United Parcel Service (UPS). UPS filed the petition, RM-6595, "to assist the commission in the formulation of service rules for the 220MHz to 222MHz band and to ensure that the much needed spectrum is available on a timely basis."

ARRL requests the FCC to dismiss the petition for three reasons:

- The petition's review of the UPS rationale for the frequency allocation is inconsistent with the stated purpose of the petition.
- Coordination between the non-government and government primary users (under the allocation plan) must be effected before service rules may be considered.
- Administrative and other recourses being pursued by amateurs to reverse the allocation decision have not been exhausted.

The association of individual amateur radio operators' comment reads, "It is apparent that UPS submitted its petition primarily as an attempt to justify the frequency allocation relative to the Docket 87-14 appeals, rather than to establish permanent operating parameters for the private land mobile use of the band."

The ARRL comment notes that more than 500 petitions for reconsideration of the 220MHz allocation are on file with the FCC. Action favorable to amateurs on any of the petitions might render moot any action taken on the UPS petition in the meantime.

Proposal broadens rules for private radio eligibility

An FCC rulemaking proceeding may lead to expanded eligibility for:

- private land mobile two-radio licenses.
- users of private carrier paging service.

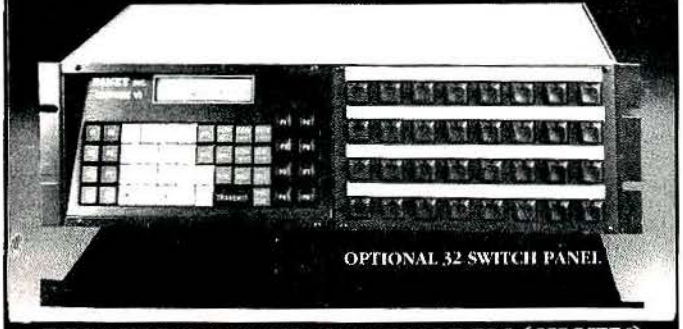
In the first instance, the commission proposes to allow previously ineligible entrepreneurs to license radio systems not for their own use, but for use by others. The other users must be eligible for licenses under Part 90 of the FCC rules.

The effect is to make private two-way radio service available to those who have no interest in licensing, building and maintaining their own radio systems but whose communication requirements would be satisfied by purchasing such service.

In the second instance, the commission proposes to extend eligibility to use private carrier paging service to individuals and the federal government. The current list of users is limited to those who are eligible for licenses under Part 90 of the FCC rules. Users are not *required* to be licensed; the *eligibility* for a license is the standard that has been applied as a qualification to use private carrier paging service.

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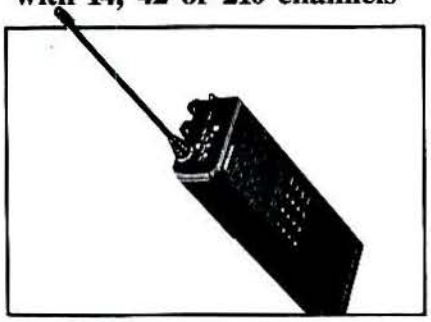
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Circle (97) on Fast Fact Card

Readers' choice

Of all the new products and services covered in the November 1988 issue of *MRT*, the ones reprinted here generated the most reader requests for additional information. If you missed them the first time, here is your opportunity to acquire more information on them: Just circle the corresponding Fast Fact number on the Fast Fact Card found in the back of this issue and mail the card to us.

Synthesized portable comes with 14, 42 or 210 channels



The LPU series synthesized portable from **Bendix/King** is available in three versions: 14 channel, 42 channel and 210 channel. Features include scan and priority scan, DTMF encode, DTMF ANI, busy-channel indicator and busy-channel lockout. Standby current drain is 20mA. The models operate over a wide band of frequencies. Once programmed, a radio can down load another unit through a special cloning cable. RF output is 4W.

Circle (386) on Fast Fact Card

Mobile data terminal includes preformatted forms



The 9100 mobile data terminal from **Mobile Data International** is a platform to be a mobile work station. The terminal is upgradeable and has preformatted forms, a single-key status keyboard and a CRT screen capable of as many as 10 message lines with 32 characters each. The compact unit features an ergonomic design.

Circle (388) on Fast Fact Card

BASE STATION

Antennas For UHF/VHF

Our low cost, highly reliable omni-directional base station antennas are available in a variety of frequency ranges and gain factors.

FEATURES

- Encapsulated in Black PVC.
- 100 Mph wind survival rating.
- Heavy wall aluminum sleeve.
- VHF - unity or 3dB models.
- UHF - unity, 3dB or 5dB models.

Electrical

- 250W continuous power rating.
- DC ground lightening protection.
- Frequency Range:
  VHF 144-174 MHz w/6 MHz Bandwidth.
  UHF 406-512 MHz w/10 MHz Bandwidth.

Mechanical

- Height:
  VHF: Unity = 69"; 3dB = 85"
  UHF: Unity = 24"; 3dB = 58"; 5dB = 75"

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1601 Voice Storage Unit

1401 Morse Code Automatic Station Identifier

- Interfaces with any transmitter.
- Dual power AC-DC operation.
- Speaker monitor.
- Switch-set digital timer.
- 3-channel activity monitors help prevent channel interruption.

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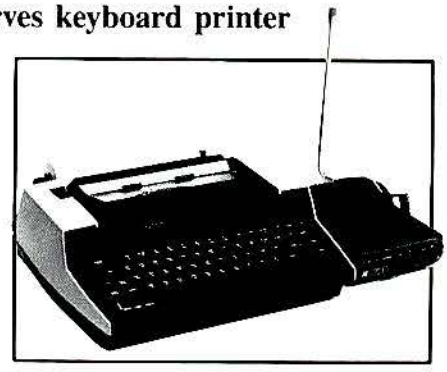
VHF portable meets military specs



The MPH series VHF rugged portable from **Bendix/King** now is certified for military specs 810 C and D for low pressure, high temperature, low temperature, temperature shock, solar radiation, rain, humidity, salt fog, dust, vibration and shock. The portable has 5W output.

Circle (387) on Fast Fact Card

Packet radio modem option serves keyboard printer



Qwint keyboard printer users can send and receive written messages over radiolinks with the company's packet radio modem option. The RDM1200 radio data modem interfaces the company's printer terminal and any voice radio. It connects to the mic and speaker jacks of a voice transceiver. The unit incorporates a digital output for controlling PTT circuitry and for switching into transmit mode under control of the packet radio protocol. It is compatible with UHF, VHF and HF. A jack and cable are provided with the unit.

Circle (409) on Fast Fact Card

SWAT mic allows hands-free operation



Circle (260) on Fast Fact Card

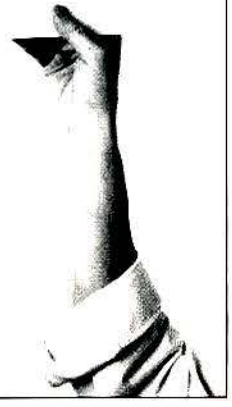
The SWAT Ear-Mike from **Magnum Distribution** offers a remote push-to-talk switch that can be strapped to the barrel of a rifle for hands-free operation. The mic also can be keyed from the interface module that is worn on the belt. The unit has a high collar switch protector, a clip and a custom ear mold kit.

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Developed specifically for the communications service professional, Computer Resources' system allows your business to operate at peak performance. Not only full service accounting but specialized packages for service management, RCC billing and invoicing, SMR billing, and Sales Management. We provide a total package including hardware, software, installation and training.

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Magnasync and the Specialist Plus Logging Recorder System. Once it's been installed you may never have to call us for repairs. It's dependability like this that has made us a leader in the industry. Call today for details.

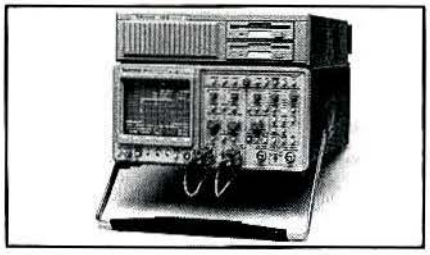
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Circle (85) on Fast Fact Card

Waveform processing product features storage capability



The 2402 TekMate software and hardware assembly from **Tektronix** is compatible with 2400 series oscilloscopes and enables waveform processing and storage. More than 500 waveforms and logging date and time information can be stored.

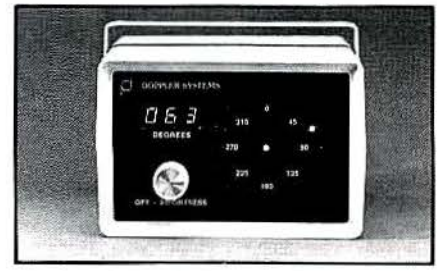
Circle (309) on Fast Fact Card

DTMF mic, autodialer mic conform with GE MVS radio

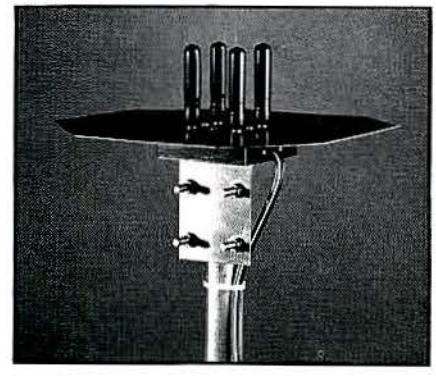
Model 600L manual dialing DTMF mic and model 710 autodialing- auto ANI mic from **CES** fit the GE MVS radio via a special connector and internal circuitry.

Circle (323) on Fast Fact Card

Radio direction finding units offer a wide frequency range



Model DDF5002 display unit.



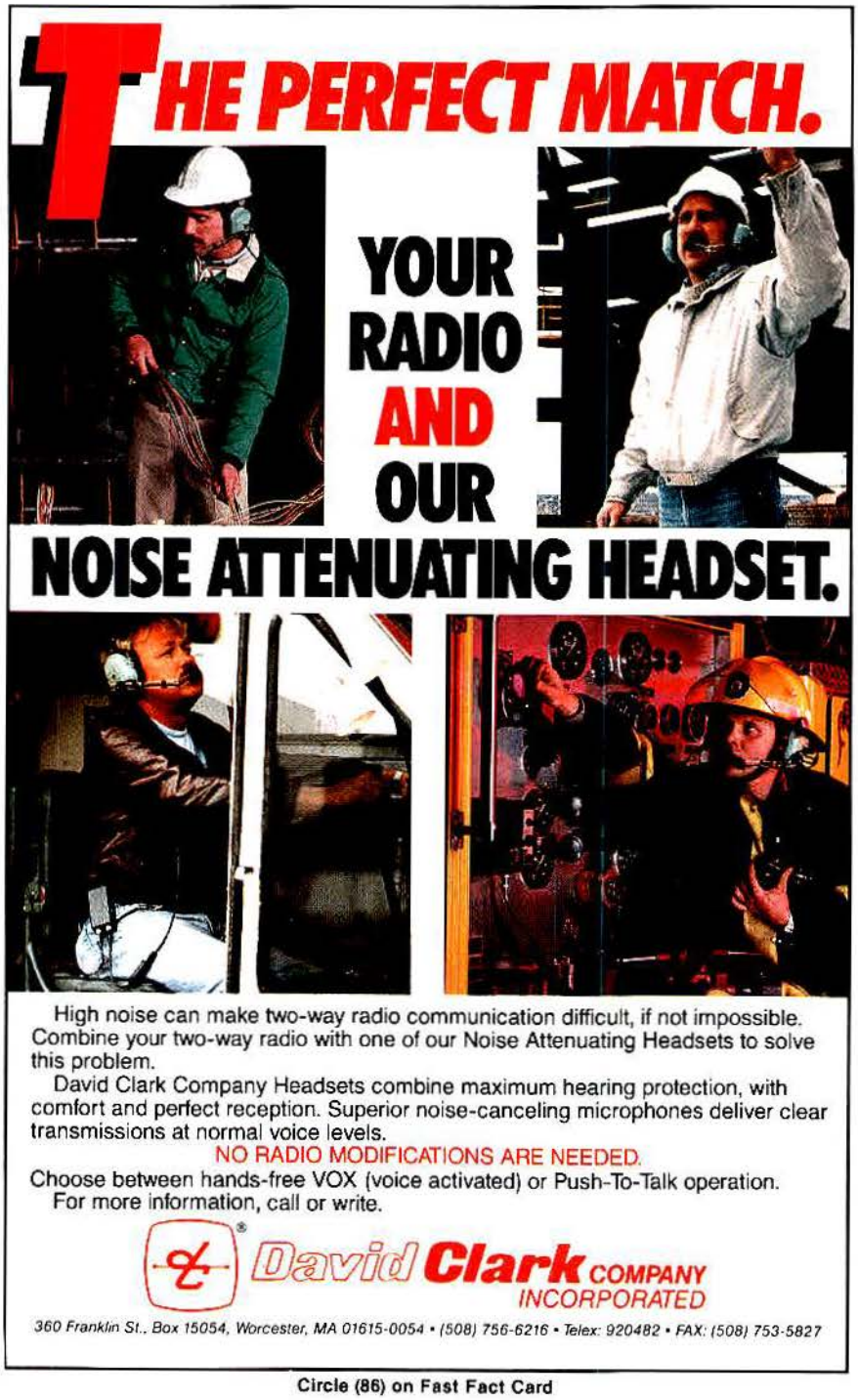
Model 5057 mast-mounted antenna for 700MHz to 1,000MHz.

Doppler Systems' expanded line of radio direction finding systems cover frequencies to 1GHz. The series 5000 units feature a wide frequency range using a remote RF summing circuit and improved accuracy. Typical accuracy is ±5°. Antennas available cover 108MHz to 1,000MHz.

A typical installation includes a processor and display unit, an RF summer unit and at least one antenna. A receiver is required.

Models available include the DDF5001, which displays the bearing with 16 LEDs arranged in a circle; the DDF5002 with a three-digit display for 1° resolution; the DDF5003 with an RS-232C serial interface; and the DDF5004 with synthesized speech capability.

Circle (390) on Fast Fact Card



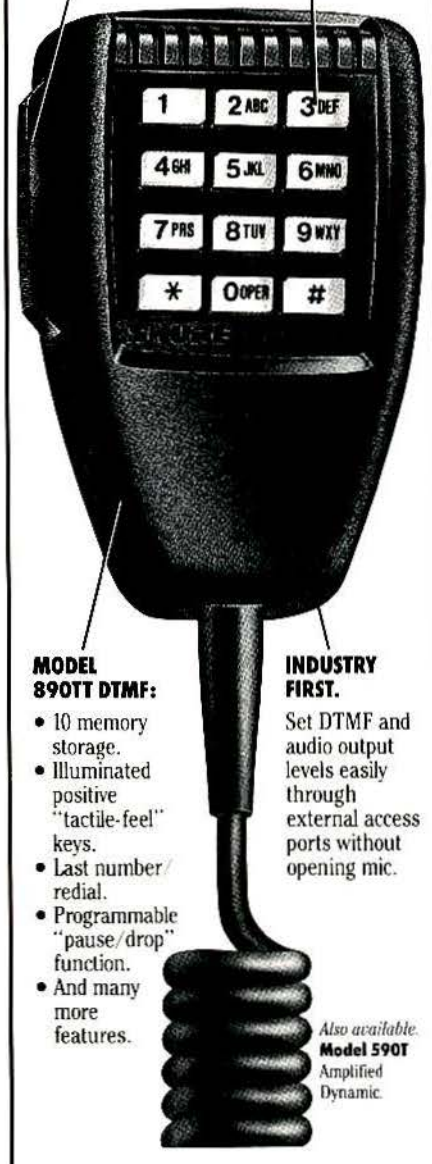
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SNAP ON

THE MODULINK CORDSET TO THE MOST ADVANCED DTMF MICROPHONE MADE

INDUSTRY FIRST.
Only DTMF mic with famous Shure Million Cycle Plus™ leaf switch for reliable operation.

INDUSTRY FIRST.
All functions, including illumination, work off mic line — no need for separate power.



MODEL 890TT DTMF:
- 10 memory storage.
- Illuminated positive "tactile-feel" keys.
- Last number redial.
- Programmable "pause/drop" function.
- And many more features.

INDUSTRY FIRST.
Set DTMF and audio output levels easily through external access ports without opening mic.

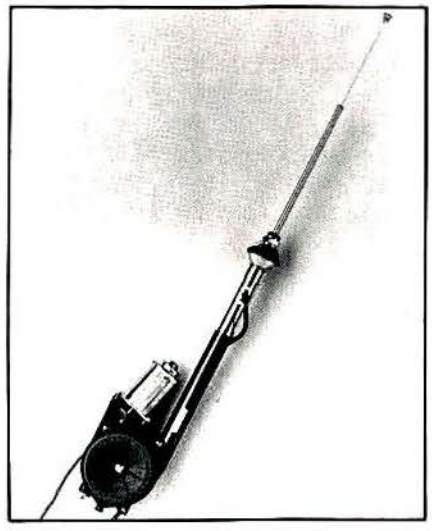
Also available.
Model 590T
Amplified Dynamic.

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Circle (87) on Fast Fact Card

New products

AM, FM, cellular antenna uses universal mounting kit



A combination automatic AM, FM and cellular antenna from **Nippon Antenna** comes with a universal mounting kit and is a phase shifter type of antenna. Model TS-50SC/SCB allows manual operation (push and pull) in case of power failure or freezing without damaging its gears.

Circle (424) on Fast Fact Card

Rechargeable nicad batteries span 500 to 2,000 cycles

Rechargeable button cell nicad batteries introduced by **Power-Sonic** have a service life of 500 to 2,000 charge-discharge cycles. Models include the PS-B60 1.2V, 600mAh battery; model PS-B100 1.2V, 100mAh battery; model PS-B170 1.2V, 170mAh battery; and model PS-B280 1.2V, 280mAh battery. The button cells can be configured as single cells or assembled in stacks, side by side or nestled.

Circle (462) on Fast Fact Card

Paging system enables networking, digital formats

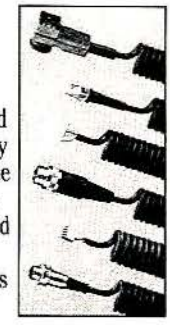
The TNPP network paging system from **Blackhawk Paging Terminals** receives national or local TNPP network data and is capable of processing digital paging formats for a local paging system. The terminal handles all paging formats for local paging and has a voice prompt feature.

Circle (465) on Fast Fact Card

TALK OUT

SHURE MODULINK...THE FIRST MODULAR MOBILE CORDSET/MICROPHONE SYSTEM

Just 30 seconds—that's all it takes to get a mobile system up and operating if cord failure occurs. ModuLink System 1 from Shure makes it that fast, because microphone and cordset are *separate* modular units.

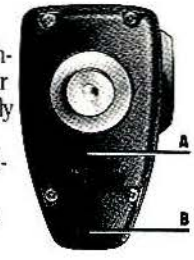


ModuLink System 1 is the first cost-effective mobile microphone/cordset system designed to reduce your inventory and improve your service efficiency. Now you can simply stock cordsets and a single line of microphones for all the radios you use and service.



ERGONOMIC DESIGN.
ModuLink microphones feature Top-Talk Sound Channels™ which end muffled voice input if the user grips the mic from the front.

SET LEVELS FAST.
Now, adjust audio without opening the mic or the radio. Level is easily set through external access port (A). Cordset can be quickly released from mic via access port (B).



For more information about MODULINK SYSTEM 1, call toll-free **1-800-257-4873** (in Illinois, call 1-800-624-8522). Or fill out and mail coupon below.

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Communications Products, Dept. 1511
222 Hartrey Avenue, Evanston, IL 60202-3696

YES, please tell me more about ModuLink System 1.

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Title _____
Company _____
Address _____
City _____ State _____ Zip _____
Phone _____
AREA CODE

MR079M

SHURE® MODULINK™

Circle (87) on Fast Fact Card

High-gain cellular antennas include voltage-feed design



Models CMX490 and CMX491 Full Spectrum cellular antennas from **Ora Electronics** feature 5dB gain, low SWR, wide bandwidth and a voltage-feed design. The CMX491 is a whistle-free version. Units in the series fit a variety of mounts.

Circle (403) on Fast Fact Card

Bilingual voice prompts selectable for pages

Bilingual voice prompts by **Commonwealth Communications Industries** are used for entering tone-only, tone and voice, display, and display and voice pages. The languages are selectable by subscriber. The voice prompt features are available in an add-on board to existing trunk cards that fit all Mark paging terminals.

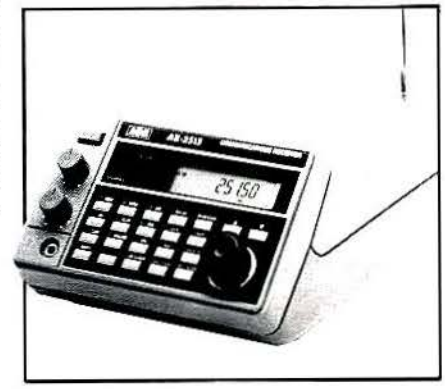
Circle (466) on Fast Fact Card

Terrain database aids in radio coverage analysis

Consulting engineering services from **Hartech** include analysis of radio coverage for two-way and microwave radio. Using a terrain topographical database, system parameter and antenna characteristics, the firm calculates coverage for fixed and mobile stations. Terrain profiles, height above average terrain and signal path calculations are also available.

Circle (438) on Fast Fact Card

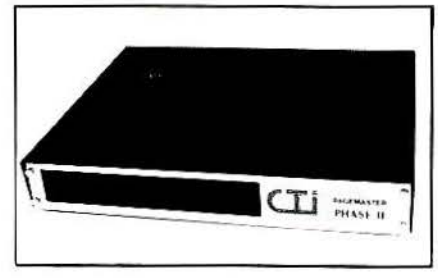
2,000-channel scanner covers 5MHz to 1,500MHz



Frequency coverage of 5MHz to 1,500MHz and 2,000-channel scanning capability are features on **Ace Communications'** AR2515 scanner. The scanner is designed for tabletop or underdash use. The unit has a built-in RS-232 interface that allows computer programming of the unit.

Circle (407) on Fast Fact Card

Paging terminal upgrades include HSC encoding



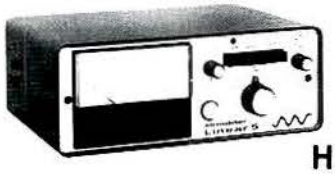
Since its introduction, the Page Master Phase II paging terminal has been capable of analog and digital encoding. Now, **CTI** has upgraded the terminal to include HSC and digital voice prompting.

The HSC encoding incorporates Maxon and Seiwa battery-saving encoding provisions and over-the-air programming capability. Custom voice prompts give the caller brief instruction messages. As many as four messages may be used to help a caller to send a paging message free of errors. The voice prompts replace call progress tones.

The terminal's features are programmed for individual subscribers, using menu-driven software, a keyboard and a CRT display.

Circle (389) on Fast Fact Card

SL-105 SINADDER™ NOW—WITH AUDIO DISTORTION SCALE



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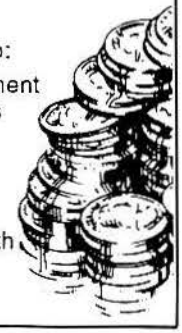
• Fill your job openings • Buy and sell your new/used equipment
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ASTRON POWER SUPPLIES



MODEL VS-50M

• HEAVY DUTY • HIGH QUALITY • RUGGED • RELIABLE •

RS, RM and VS SERIES

SPECIAL FEATURES

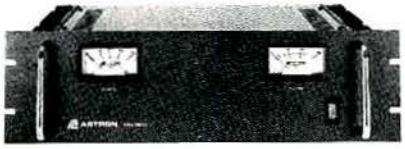
- SOLID STATE ELECTRONICALLY REGULATED
- FOLD-BACK CURRENT LIMITING Protects Power Supply from excessive current & continuous shorted output.
- CROWBAR OVER VOLTAGE PROTECTION on all Models except RS-4A, RS-5A.
- MAINTAIN REGULATION & LOW RIPPLE at low line input Voltage.
- HEAVY DUTY HEAT SINK • CHASSIS MOUNT FUSE
- THREE CONDUCTOR POWER CORD
- ONE YEAR WARRANTY • MADE IN U.S.A.

PERFORMANCE SPECIFICATIONS

- INPUT VOLTAGE: 105 - 125 VAC
- OUTPUT VOLTAGE: 13.8 VDC ± 0.05 volts (Internally Adjustable: 11-15 VDC)
- RIPPLE: Less than 5mv peak to peak (full load & low line)
- Also available with 220 VAC Input Voltage

19" X 5¼ RACK MOUNT POWER SUPPLIES

RM-A SERIES


MODEL RM-35M

MODEL	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H x W x D	Shipping Wt. (lbs.)
RM12A	9	12	5¼ x 19 x 8¼	16
RM-35A	25	35	5¼ x 19 x 12½	38
RM-50A	37	50	5¼ x 19 x 12½	50
• Separate Volt and Amp Meters				
RM-35 M	25	35	5¼ x 19 x 12½	38
RM-50 M	37	50	5¼ x 19 x 12½	50

RS-A SERIES


MODEL RS-7A

RS-4A	3	4	3¾ x 6½ x 9	5
RS-5A	4	5	3½ x 6⅛ x 7¼	7
RS-7A	5	7	3¾ x 6½ x 9	9
RS-10A	7.5	10	4 x 7½ x 10¾	11
RS-12A	9	12	4½ x 8 x 9	13
RS-20A	16	20	5 x 9 x 10½	18
RS-35A	25	35	5 x 11 x 11	27
RS-50A	37	50	6 x 13¾ x 11	46

RS-M SERIES


MODEL RS-35M

• Switchable volt and Amp meter				
RS-12M	9	12	4½ x 8 x 9	13
• Separate volt Amp meters				
RS-20M	16	20	5 x 9 x 10½	18
RS-35M	25	35	5 x 11 x 11	27
RS-50M	37	50	6 x 13¾ x 11	46

VRM/VS-M SERIES


MODEL VS-35M

- Separate Volt and Amp Meters • Output Voltage adjustable from 2-15 volts
- Current limit adjustable from 1.5 amps to Full Load

	@13.8VDC	@10VDC	@5VDC	@13.8V		
VS-20M	16	9	4	20	5 x 9 x 10½	20
VS-35M	25	15	7	35	5 x 11 x 11	29
VS-50M	37	22	10	50	6 x 13¾ x 11	46
• Variable rack mount power supplies						
VRM-35M	**25**	**15**	**7**	**35**	**5¼ x 19 x 12½**	**38**
VRM-50M	**37**	**22**	**10**	**50**	**5¼ x 19 x 12½**	**50**

*ICS—Intermittent Communication Service (50% Duty Cycle 5 min. on 5 min. off)

DC-DC CONVERTERS


MODEL 1212


MODEL 1212-16

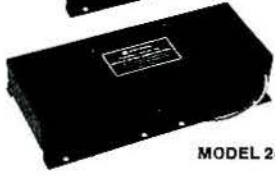
MODEL 1212 & 1212-18 Switching Regulated Converter.

Designed for FM transceivers and other applications requiring 12 volt power source converted from 12 volt positive ground battery. Regulation with pulse width modulation at 20 KHz.

Input—12V DC (Positive ground only). Functional from —11 V DC to—16 V DC. Output +13.8 V DC (Negative ground only).

	1212		1212-18	
Output Voltage	13.8 V DC	±.2 V DC	13.8 V DC	±.2 V DC
Line/Load Regulation	200 mV		200 mV	
Ripple/Noise	50 mV RMS		50 mV RMS	
Current Continuous	6 Amp		14 Amp	
Current (ICS)	9 Amp		18 Amp	
Current Limit	12 Amp		19 Amp	
Case	2¾" (H) x 6" (W) x 6" (D)		2¾" x 6" x 12"	
Shipping Weight	2 lbs.		4 lbs.	


MODEL 2412


MODEL 2412-16

MODEL 2412 & 2412-16 Switching Regulated Converter.

Designed for FM transceivers and other applications requiring 12 volt power source converted from 24 volt battery. Regulation with pulse width modulation at 20 KHz.

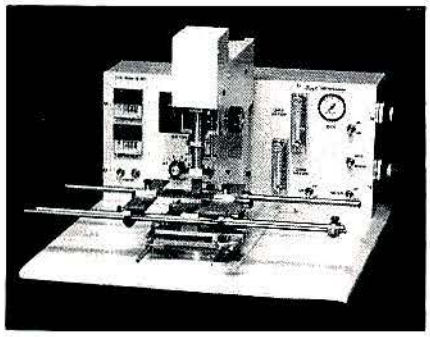
Input +28 V DC (Negative ground only). Functional from + 22 V DC to +32 V DC. Output +13.8 V DC (Negative ground only).

	2412		2412-16	
Output Voltage	13.8 V DC	±.2 V DC	13.8 V DC	±.2 V DC
Line/Load Regulation	200 mV		200 mV	
Ripple/Noise	50 mV RMS		50 mV RMS	
Current Continuous	9 Amp		16 Amp	
Current Limit	12 Amp		20 Amp	
Case	2¾" (H) x 6" (W) x 6" (D)		2¾" x 6" x 12"	
Shipping Weight	2 lbs.		4 lbs.	

ALSO! AVAILABLE AS MODEL 3612 & 3612-16: +36 V DC (Negative ground only) AND AS MODEL 4812 & 4812-16: +48 V DC (Negative ground only).

Circle (98) on Fast Fact Card

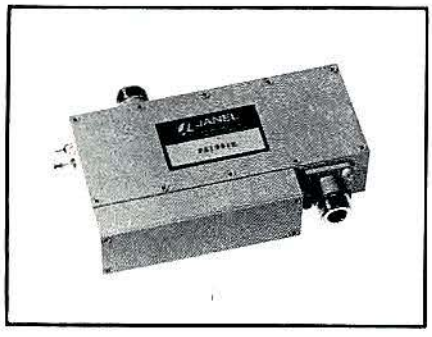
SMD workstation features rotational table movements



The Eisy SMD workstation line from **Electronic Instrument & Specialty** features instant-on heating, rotational table movements with verniers, halogen lighting and vacuum control.

Circle (416) on Fast Fact Card

25W cellular amplifier spans 20MHz bandwidth



Model PA1991 25W linear amplifier from **Janel Laboratories** maintains low intermodulation distortion and covers a 20MHz bandwidth in the 800MHz to 900MHz range.

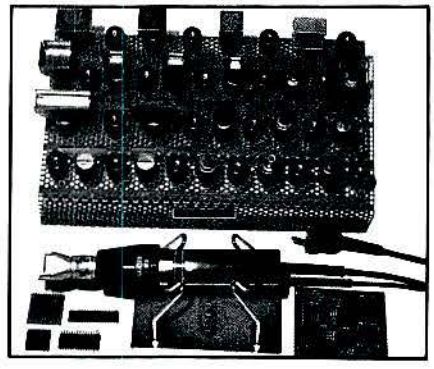
Circle (405) on Fast Fact Card

Message dispatch software permits alphanumeric paging

The MD2001 PC message dispatch system software package offered by **Fitzgerald Telecommunications** supports Motorola's and IXO's remote entry requirement for alphanumeric paging over a standard dial-up telephone. The software is window-driven and features page by name, group or page number with multiple terminal access; RAM resident option to suspend current program while paging; ASCII file input; time and data stamp with message to printer or hard disk; and directory listing by name, group, terminal and pager number.

Circle (422) on Fast Fact Card

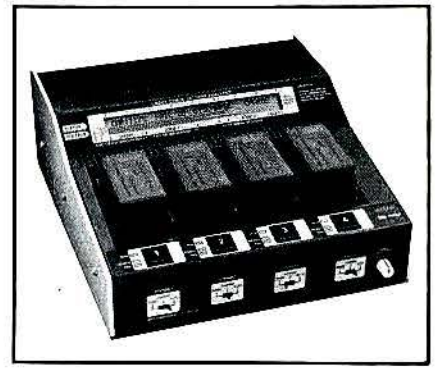
Hot-air tool contains double insulation



The Leister Hot-Jet "Flex" hot-air tool from **Brian R. White** solders and desolders surface-mount devices and DIP components between 20°C and 200°C via hot air. The double-insulated tool comes with a standard 5mm nozzle; other nozzles are available.

Circle (311) on Fast Fact Card

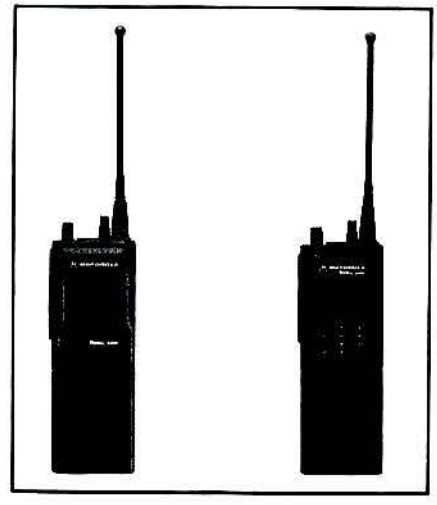
Analyzer restores nicad batteries



The C2000 battery analyzer from **Cadex Electronics** rejunevates nicad batteries automatically. Features include independent program setting for each station and target capacity selector. The analyzer can restore four batteries simultaneously, and each station can be configured to a different battery type.

Circle (321) on Fast Fact Card

Synthesized portable adds cloning capability



The Radius P200 synthesized portable from **Motorola** has data-stored intelligence that includes frequencies, squelch codes and operating characteristics. Use of a cloning cable allows duplication of one radio's characteristics to another P200 radio of the same subband. The portable exceeds 11 criteria of military spec 810C and 810D. Three codes per radio are selectable. The radio has a battery-saving feature.

Circle (246) on Fast Fact Card

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Circle (99) on Fast Fact Card

Frequency translator spans 4kHz to 8kHz microwave

Model 2404 frequency translator for microwave systems provides use of DTMF signaling in the 4kHz to 8kHz microwave slot. One **Lucas Ledex** translator can translate all co-located DTMF equipment.

Circle (237) on Fast Fact Card

Dash-mount mobiles boast 80W UHF, 110W VHF output



Challenger Plus 2 VHF and UHF mobiles have 99-channel capacity and expanded dual priority scan operation. The **E. F. Johnson** dash-mount mobiles offer 110W of RF in VHF and 80W in UHF. The mobiles meet Mil Std 810C and D.

Circle (428) on Fast Fact Card

Morse code training program comes on floppy diskette

Super Morse, written by Lee Murrah, works with any IBM or compatible computer. The shareware program from the **National Amateur Radio Association** teaches Morse code in four phases:

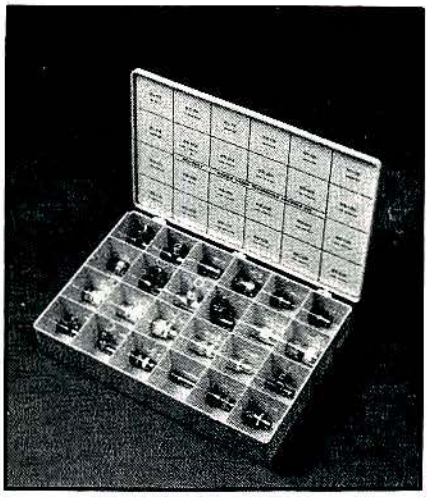
1) learning the characters.
2) building speed.
3) enhancing skills.
4) measuring progress.

Characters are seen on the computer display and heard over the speaker in the MS-DOS computer.

A demonstration on proficiency in Morse code is one step toward earning a license in the amateur radio service. Copies are free; the postage and handling charge is $3.

Circle (385) on Fast Fact Card

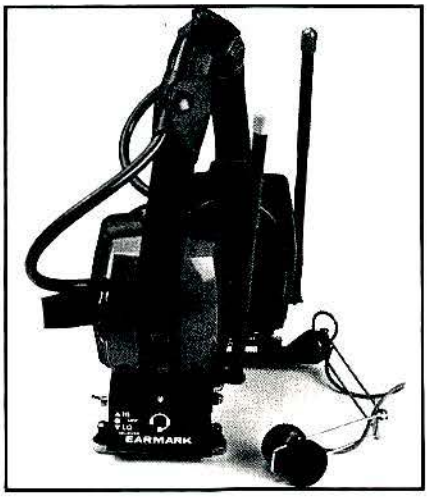
Connector adapter kit contains 24 components



An adapter kit, RFA-4021, from **RF Industries** includes 24 interseries coaxial connector adapters, including N, UHF and BNC. All adapters have machined-brass bodies with silver or nickel plating.

Circle (418) on Fast Fact Card

Headsets offer power control, battery indicator light



Series 3 and 3W headsets from **Earmark** feature improvements such as built-in battery indicator light, high-low power switch and a high-low volume control. The new headset has an over-the-head spring band and muff puffs for increased ear clearance. The headsets operate on alkaline batteries or the company's rechargeable power system.

Circle (319) on Fast Fact Card

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Write or call today for "Your Personal Telephone Interconnect Planning Guide" – an informative booklet brimming with useful information on how to connect your radios to the public switched telephone network, system characteristics, types of interconnects, installation of interconnects, FCC licensing and more.

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Circle (200) on Fast Fact Card

Mobile transforms into full-duplex, trunked formats



Circle (257) on Fast Fact Card

The TMX 8712 mobile radio from **General Electric** functions as a two-way trunked unit and a full-duplex mobile telephone. Telephone features include autodialer, backlit keypad and last-number redial. Radio dispatch features include accessibility to as many as 36 trunked systems with nine user groups per system, optional repeater talk-around and optional external speaker.

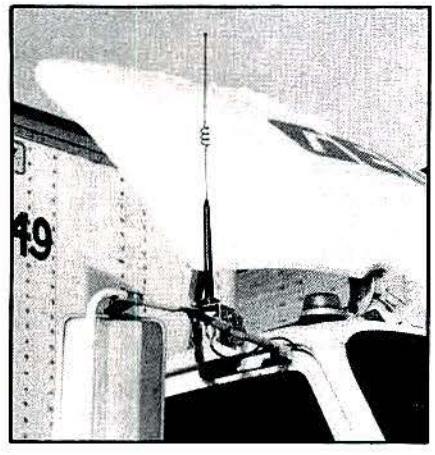
GE MVS radio is available with dual control units



The GE MVS radio is available with dual control units offered by **D&L Communications.** The dual control MVS connects two MVS remote-mounted control units to one MVS radio without a junction box. Functions operated at one control unit are updated and displayed instantaneously at the other. The dual control product offers wideband flexibility in VHF and UHF.

Circle (316) on Fast Fact Card

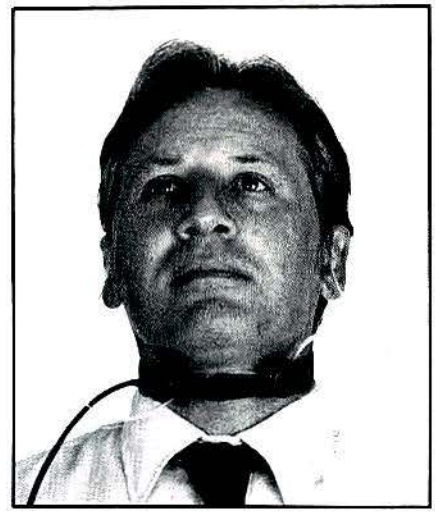
Antenna is designed for truck, van use



A 3dB gain mirror- or side body-mount antenna from **Antenna Specialists** is designed for trucks, vans and motorhomes. Model ASPD913 provides omnidirectional coverage and is ground-plane independent. The unit's radiator, spring and mounting hardware are stainless steel with a black coat finish.

Circle (312) on Fast Fact Card

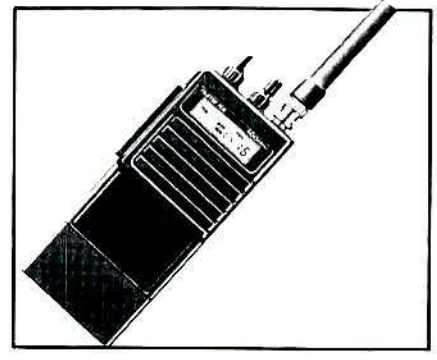
Headset incorporates waterproof throat mic



The Neckset headset from **Television Equipment Associates** has a waterproof throat mic and shower-proof receive speaker in leather-covered modules. An adjustable, elastic strap fastens around a user's neck with a clip. A transparent voice tube carries the receive signal from the neck strap to one or both of a user's ears.

Circle (251) on Fast Fact Card

16-channel portables offer 5W, 2W output



Two 16-channel portables from **Fujitsu Ten** feature priority scanning, flat bandpass characteristics, field-programmable transmit and receive, channel indicator, CTCSS encode and decode tones, time-out timer and scan functions. Output of 5W or 2W is user selectable by choice of 12V or 7.2V nicad battery. Model FTP40-554AT is the UHF version; model FTP15-554AT is the VHF unit.

Circle (264) on Fast Fact Card

The BEST NAM Programmer Money Can Buy.



$ 995.

The NAMPRO-300D™

- 40 Character LCD guides user thru Menus of Cellular Telephone Models and their Options.
- Stores and Recalls 32 NAMs.
- **FREE** Printer Port.
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Circle (201) on Fast Fact Card

Antenna brochure describes cellular glass-mount line

Ora Electronics' Full Spectrum glass-mount antennas are detailed in a six-page brochure that is available to the company's dealers and distributors. Glass-mount technology and antenna benefits are outlined in the literature.

Circle (429) on Fast Fact Card

Catalog contains reflectors, antenna support structures

Microflect's 18GHz to 23GHz antenna support structures and reflectors catalog covers 23 support structures and 40 passive reflectors. Tripods, monopoles, wall mounts and roof-mounted frames are listed.

Circle (430) on Fast Fact Card

Cellular products catalog highlights various brands

"Super Savings on Cellular Products" from **Tessco** features cellular items from a variety of manufacturers including Antenna Specialists, Decibel, Celwave, Shure, Helper, Bird and IFR. The catalog lists new products, selected control heads and glass-mount antennas.

Circle (431) on Fast Fact Card

Technical bulletin describes modulation meter

A technical applications bulletin describes **Marconi's** model 2305 modulation meter, which spans 50kHz to 2.32GHz. Block diagrams detail the operation, setup and measurement of audio signals with the unit.

Circle (427) on Fast Fact Card

License question manual aids in FCC, marine exams

The *Radio Operator's License & Question Answer Manual* from **Hayden Books,** a division of Howard W. Sams, covers basic law, operating practice and radiotelephone information. It includes questions formatted similar to those on the FCC general radiotelephone license exam, marine radio permit exam and private industry electronics certification exams. The book includes a summary of FCC radio operator license rules and field offices and certification programs for technicians.

Circle (502) on Fast Fact Card

Report outlines growth in cellular distribution

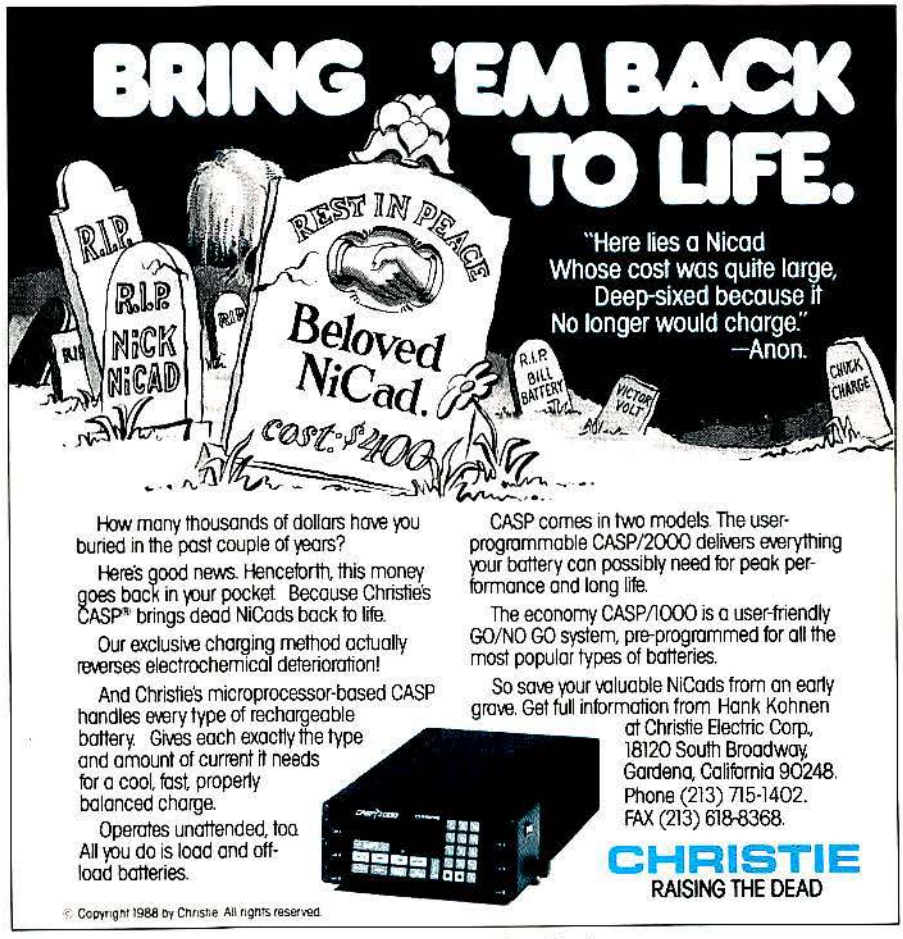
"Cellular Brand Sales" from **Herschel Shosteck Associates** focuses on the growth in cellular distribution channels over the past year. Information includes shares for mobile and mobile-transportable units, percent of manufacturer's market share and sales estimates.

Circle (503) on Fast Fact Card

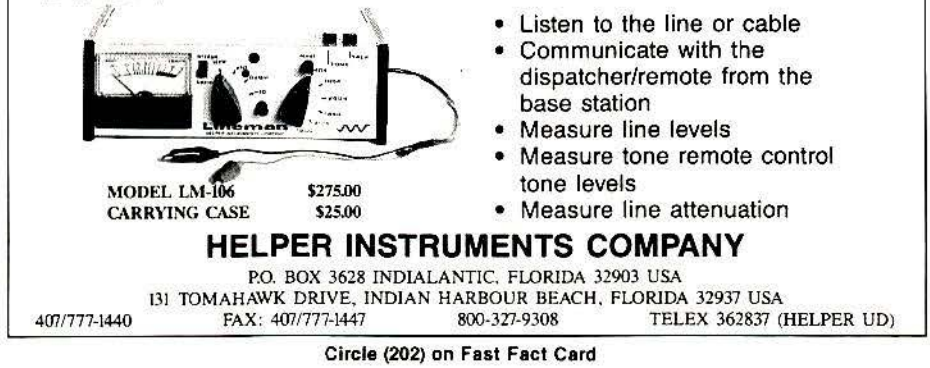
Brochure describes scalar network analyzer

The 562 scalar network analyzer from **Wiltron** is described in a four-page brochure. Specifications, front-panel functions, applications and an accuracy table are included.

Circle (504) on Fast Fact Card



Circle (90) on Fast Fact Card



Circle (202) on Fast Fact Card

MOVING?

Take us with you.

Just peel off your subscription mailing label and attach it to the address change card inside this issue. Please allow 6–8 weeks to process your address change.

Buyers' Guide serves as handy reference

The 1989 Buyers' Guide is "a consolidated reference for products and services," concur respondents of the December 1988 "What Do You Think?" questionnaire. "It keeps us up to date on changes and features," adds a reader. "Your magazine is a cake, and the Buyers' Guide is the frosting," agrees a reader.

The median time readers spend perusing the Buyers' Guide the first time through is 53.7 minutes, with the majority of the respondents, 41.4%, spending 30 minutes to an hour reading it on the first time through. Others will spend even more time delving into the issue as reported in these statistics:

Time spent reading Buyers' Guide	%
Less than 30 minutes	17.4%
30 minutes to 1 hour	41.4%
1 hour to 2 hours	28.4%
2 hours or more	12.8%
Did not read	0

With subscribers retaining the issue as a year-round reference, the time spent reading the issue increases even more. According to responses, 51.4% of the readers will retain the Buyers' Guide for 12 months or more. Comments indicate that the issue will be filed when the next annual Buyers' Guide comes off the presses in December 1989. The length of time to retain the issue includes:

Length of time readers plan to keep the Buyers' Guide	%
1 to 2 months	3.7%
3 to 6 months	9.2%
6 to 12 months	33%
12 months or more	51.4%
No answer	1%
Do not plan to use	1.8%

The Buyers' Guide garners even more readership in pass-along issues. Pass-along issues include 40.4%, according to respondents. Readers indicate the issues will be shared with management, administration, engineering and technical staffs and others within their facilities.

Of the Buyers' Guide sections, readers note the product and services directories are the most used, followed by the company addresses section.

Readers plan to use the Buyers' Guide as a product source:

- by circling numbers on the Fast Fact Card to receive literature from manufacturers.
- to contact vendors directly.
- to file for a purchasing reference.

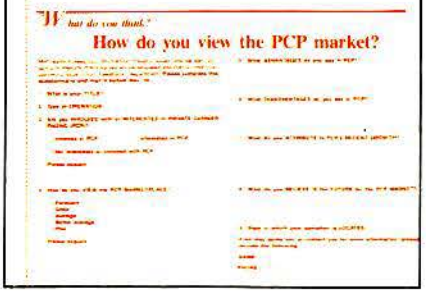
To use the guide as a purchasing reference was the most popular response, with 71.6%. It is followed by circling Fast Fact numbers to receive literature from manufacturers at 65.5%. Contacting vendors directly also ranked high at 56%.

Readers expressed various ways that they find the guide helpful. "I like the ease with which individual items or companies may be located," notes a reader. "It is useful as a reference for equipment, and the telephone directory is used regularly," adds a reader.

"I will keep the guide until the next one is available," a reader says. "I like the cross-reference capability with 800 phone numbers," cites a respondent. Another respondent likes the color highlighting for advertisers in the issue: "I like the blue listing system."

"Most manufacturers are listed. It makes a handy desk reference," states a reader. "The Buyers' Guide is a big help in finding suppliers of special products," summarizes a reader.

Be sure to fill out this month's "What Do You Think?" questionnaire on page 113 so your responses can be included in a future "Feedback" column.



People


McMahon


Brink


Knott


Weissgerber

Mark McMahon moves from sales with Maxon Electronics, Kansas City, MO, to eastern regional sales manager with Antenna Specialists, Cleveland. **Elizabeth Heldman** becomes A/S manager of training and development.

A legal specialist with the Marine Corps, **Thomas Brink,** joins Quintron, Quincy, IL, as sales administrator. He replaces **Tim Anderson,** who advances to account executive for the central United States.

Judith Knott leaves Uniroyal as territory sales manager in the southwest to join Cablewave Systems, North Haven, CT, as manager of sales administration. **Frank Weissgerber** becomes Cablewave eastern regional sales manager, departing Papst Mechatronic as national accounts manager.

Changes at Cue Paging, Irvine, CA: **Dick Hallett** vice president and chief financial officer for Cue parent Nokia North America, transfers to becomes Cue president, replacing **Gene Swanzy.** Swanzy continues on the Cue board of directors and takes a new assignment with the business and product development group at Nokia North America, Basking Ridge, NJ.

Changes at Power Conversion Products, Crystal Lake, IL: **Stephen G. Schmidt** leaves an engineering job with Schaumburg, IL-based Motorola to become account executive for northern Illinois and Wisconsin. **Al Rotschild,** north central sales manager, assumes additional sales duties within the Chicago metropolitan area.

Changes at Geostar, Washington, DC: **James R. Wilson** relinquishes duties as chief financial officer of Circuit City Stores to become Geostar senior vice president and chief financial officer. **Teresa O'Connor** leaves as senior counsel at Unisys to join the company as senior director of legal affairs. **David F. Long,** director of contract administration, advances to corporate and international director.

Don Klabunde departs as executive vice president of Tait Electronics, Houston, to join DX Communications, the Los Angeles-based division of TPL's parent company, DX Communications.

Kevin J. Kelley, steps down as chief of the FCC common carrier bureau's mobile services division to join the Cellular Telecommunications Industry Association, Washington, DC, as vice president.

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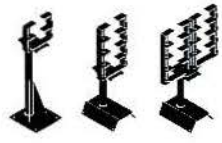


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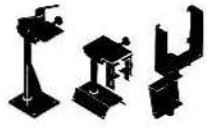
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Circle (93) on Fast Fact Card

Calendar

July

17-19—Forestry-Conservation Communications Association, Coeur D'Alene, ID. Contact: 208-765-1811.

August

6-10—Associated Public-Safety Communications Officers 55th Annual National Conference, John Ascuaga's Nugget, Sparks, NV. Contact: 800-824-1850.

27-30—International Association of Fire Chiefs Annual Meeting, Indianapolis Convention Center, Indianapolis. Contact: 202-833-3420.

September

7-9—Land Mobile Expo/East, Orange County Convention Center/Civic Center, Orlando, FL. Contact: 303-220-0600.

28-30—Special Industrial Radio Service Association Annual Meeting, Lake Tahoe Hyatt, Lake Tahoe, NV. Contact: 703-528-5115.

October

4-7—Telocator 41st Annual Convention and Exposition, Washington Convention Center, Washington, DC. Contact: 202-467-4781.

14-19—International Association of Chiefs of Police Annual Meeting, Commonwealth Convention Center, Louisville, KY. Contact: 301-948-0922.

16-17—American SMR Network Association Fall Meeting, Ritz Carlton Hotel, Rancho Mirage, CA. Contact: 202-331-7773.

November

17—Radio Club of America Annual Meeting and Awards Banquet, New York Athletic Club, New York. Contact: 201-246-7271.

18-19—Communications Marketing Conference, Denver. Contact: CMA secretary-treasurer John Ehret, TPL Communications, 213-256-3000.

1990

March

11-14—Energy Telecommunications and Electrical Association '90, San Antonio Convention Center and Hilton and Marriott hotels, San Antonio, TX. Contact: 214-578-1900.

28-30—International Mobile Communications Expo, Dallas Convention Center, Dallas. Contact: 303-220-0600.

August

26-30—Associated Public-Safety Communications Officers 56th Annual National Conference, Boston Sheraton Hotel, Boston. Contact: 800-824-1850.

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Sales offices

WEST: San Rafael, CA—Dennis Hegg, Mktg. Mgr., (415) 491-1442; FAX (415) 491-1842
MIDWEST: Englewood, CO—Cathey Bonnefoi, Mktg, Mgr., (303) 762-1249; FAX (303) 762-0069
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Contact Diane Hite at (303) 762-1249 in Denver to place your classified ad, or send your classified advertising materials and order to: **Mobile Radio Technology,** Advertising Department, P.O. Box 12901, Overland Park, KS 66212

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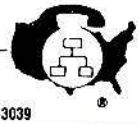
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You will be responsible for planning, budgeting and requirements definition for the implementation of Digital Narrow Channel (DNC) technology in the Los Angeles and other PacTel Cellular telecommunications systems. You will coordinate system testing, evaluate DNC equipment and manage a full-scale field test program. To qualify, you must have a BSEE and 10 years of solid technical experience. A Master's degree is preferred. Strong management skills are required. **Respond to Code DPT.**

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Technical feasibility assessment of advanced radio-based voice and data telecommunications concepts, products, systems and integrated networks. You will direct multiple business cases and technical projects in a matrix organization working as a key member or chair of a new business development team. Requires a BSEE and 8 to 15 years telecommunications experience. MSEE or MBA is a plus. Strong project management skills are required and a keen interest and expertise in technology applications. **Respond to Code DAT.**

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EOE

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EOE

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BNL BROOKHAVEN NATIONAL LABORATORY
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Send Resumes to:

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P100 PORTABLE
Model: P100 Portable



Transmitter Power: VHF: 1 or 5/1 Watts
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P50 PORTABLE
Model: P50 Portable



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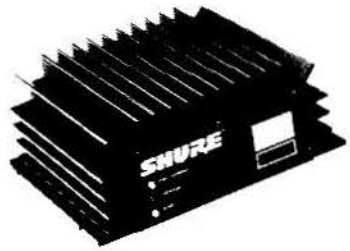
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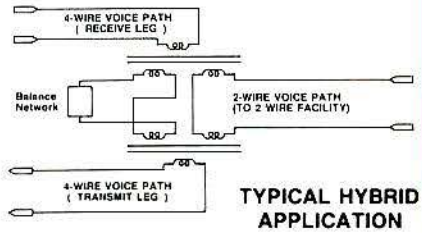
WHY THEY FAIL
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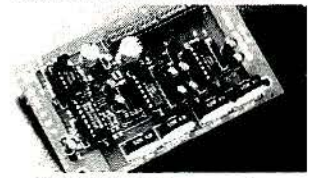
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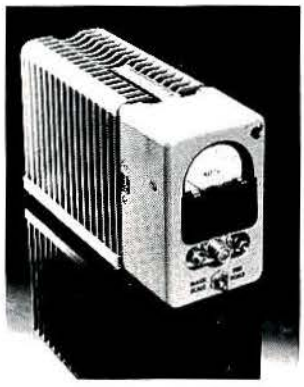
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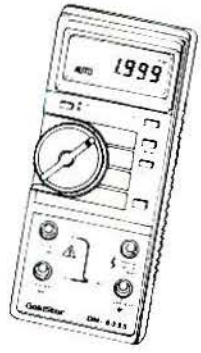
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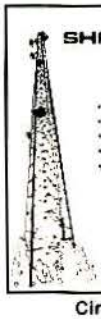
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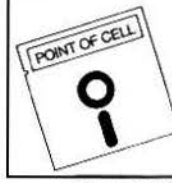
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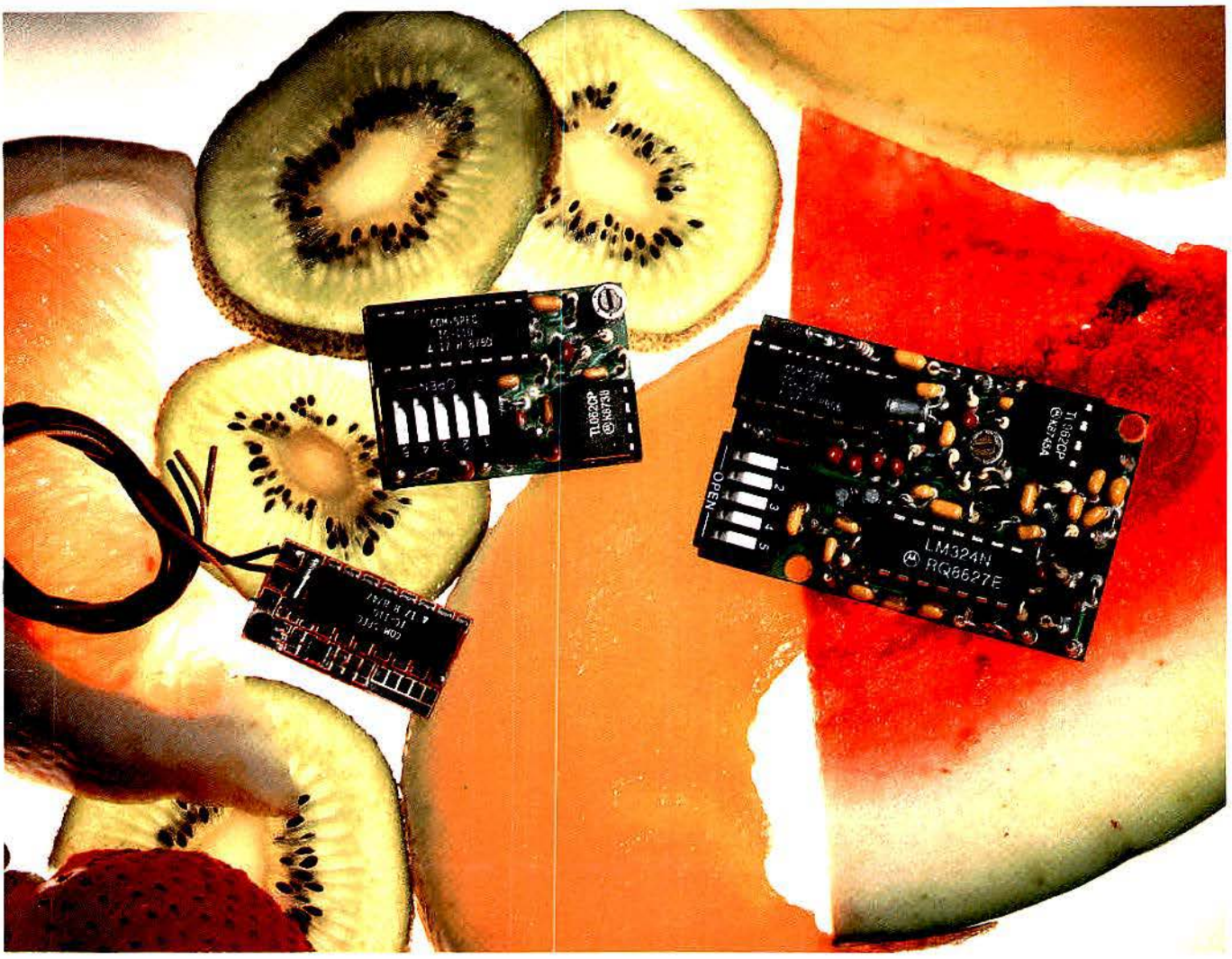
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